

Test Report

Product	Wireless Sensor with Wireless HART Processor Module
Name and address of the applicant	ABB AS Ole Deviks vei 10 NO-0666 Oslo, NORWAY
Name and address of the manufacturer	ABB AS Ole Deviks vei 10 NO-0666 Oslo, NORWAY
Model	PM002
Rating	3.7V _{DC} (Primary Battery, Lithium)
Trademark	ABB Ability Smart Sensor
Serial number	4JN0 23R3 G472
Additional information	Bluetooth LE 5.0, Wireless HART
Tested according to	FCC Part 15.247 Digital Transmission Systems Industry Canada RSS-247, Issue 2 Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
Order number	376453
Tested in period	2019-11-25 to 2019-11-26
Issue date	2020-01-16
Name and address of the testing laboratory	 Instituttveien 6 Kjeller, Norway www.nemko.com CAB Number: FCC: NO0001 ISED: NO0470 TEL: +47 22 96 03 30 FAX: +47 22 96 05 50   An accredited technical test executed under the Norwegian accreditation scheme
 Prepared by [Frode Sveinsen]  Approved by [G.Suhanthakumar]	
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1 INFORMATION

1.1 Test Item

Name	ABB Ability Smart Sensor
FCC ID	2ANYT-SSPM002AA
ISED ID	23283-SSPM002AA
Model/version	PM002
Serial number	4JN0 23R3 G472
Hardware identity and/or version	A
Software identity and/or version	5.0-4 (Version used during testing)
Frequency Range	2405 – 2475 MHz
Number of Channels	BT Low Energy: 40 Wireless HART: 15
Operating Modes	BT Low Energy 5.0 Wireless HART
Type of Modulation	GFSK
Rated Output Power	0.0026 W (Wireless HART)
Type of Power Supply	Primary Battery (3.7V Lithium)
Antenna Connector	None (Internal U-FL connectors on PCB)
Number of Antennas	1 (BT LE and Wireless HART have separate antennas)

Description of Test Item

The EUT is a Processor Module in a Wireless Sensor with Bluetooth Low Energy 5.0 and Wireless HART. Wireless HART and BT Low Energy can never operate at the same time.

1.2 Normal test condition

Temperature: 20 - 23 °C
Relative humidity: 20 - 50 %
Normal test voltage: 3.7 V DC (Nominal Battery Voltage)

The values are the limit registered during the test period.

1.3 Test Engineer(s)

Frode Sveinsen

1.4 Description of modification for Modification Filing

Not applicable.

1.5 Family List Rational

Not Applicable.

1.6 Antenna Requirement

Is the antenna detachable?

☐ Yes ☒ No

If detachable, is the antenna connector non-standard?

☐ Yes ☐ No

Type of antenna connector: N/A

Ref. FCC §15.203

1.7 Worst-Case Configuration and Mode

All tests were performed with BT LE Long Range and 2Mb Mode.

1.8 Comments

All measurements were performed with the EUT powered by a new battery.

This test report covers only the Wireless HART Part.

2 TEST REPORT SUMMARY

2.1 General

All measurements are traceable to national standards.

The tests were conducted for demonstrating compliance with FCC CFR 47 Part 15, paragraph 15.247 and Industry Canada RSS-247 Issue 2 and RSS-GEN Issue 5.

Tests were performed in accordance with ANSI C63.4-2014 and ANSI C63.10-2013.

Radiated tests were made in a semi-anechoic chamber at measuring distances of 1m and 3m.

A description of the test facility is on file with FCC and ISSED.

☒ New Submission

☒ Production Unit

☐ Class II Permissive Change

☐ Pre-production Unit

DTS Equipment Code

☐ Family Listing



THIS TEST REPORT APPLIES ONLY TO THE ITEM(S) AND CONFIGURATIONS TESTED.

Deviations from, additions to, or exclusions from the test specifications are described in "Summary of Test Data".

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2.2 Test Summary

Name of test	FCC Part 15 reference	RSS-247 Issue 2, RSS-GEN Issue 5 reference	ANSI C63.10-2013 Reference	Result
Supply Voltage Variations	15.31(e)	6.11 (RSS-GEN)	5.13	N/A
Antenna Requirement	15.203	6.8 (RSS-GEN)	5.8	Complies
Power Line Conducted Emission	15.107(a) 15.207(a)	7.2 / 8.8 (RSS-GEN)	6.2	N/A
Occupied Bandwidth (99% BW)	N/A	6.7 (RSS-GEN)	6.9.3	Complies
DTS Bandwidth	15.247(a)(2)	5.2 (1) (RSS-247)	11.8 Option 2	Complies
Peak Power Output	15.247(b)	5.4 (RSS-247)	11.9.1.1	Complies
Power Spectral Density	15.247(d)	5.2 (2) (RSS-247)	11.10.2 PKPSD (DTS)	Complies
Spurious Emissions (Antenna Conducted)	15.247(c)	5.5 (RSS-247)	6.7 11.11 (DTS)	Complies
Spurious Emissions (Radiated)	15.247(c) 15.109(a) 15.209(a)	5.5 (RSS-247) 7.3 (RSS-GEN) 8.9 (RSS-GEN)	6.3, 6.5, 6.6, 6.10 11.12, 11.13 (DTS)	Complies

Revision history

Revision	Date	Comment	Sign
00	2020-01-16	First edition	FS

3 TEST RESULTS

3.1 Occupied Bandwidth (99% BW)

FCC Part 15.247 (a)(1)(iii)

ISED Canada RSS-247 Issue 2, Clause 5.1

ISED Canada RSS-GEN Issue 5, Clause 6.7

Measurement procedure: ANSI C63.10-2013 Clause 6.9.3 / 7.8.3

Test Results: Complies

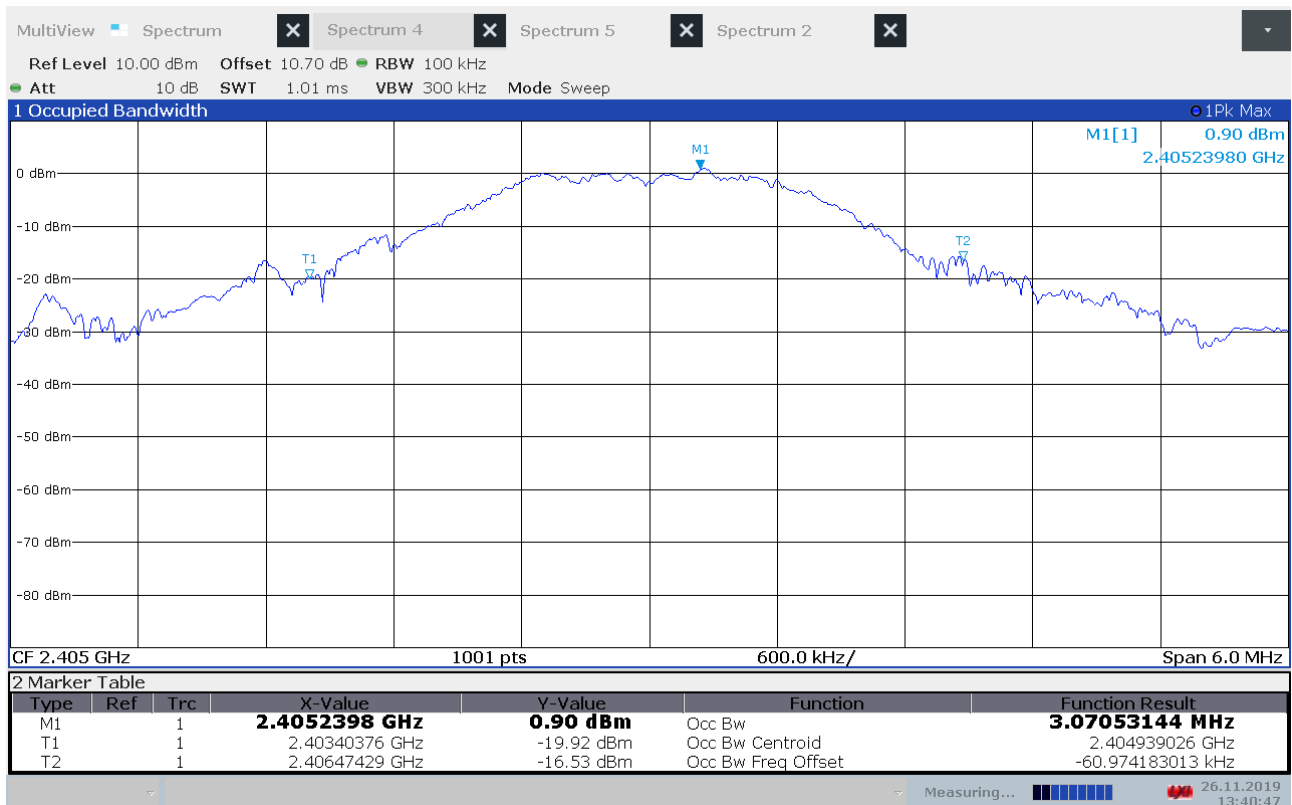
Measurement Data:

Carrier Frequency	Occupied Bandwidth (99% BW)
2405 MHz	3.07 MHz
2440 MHz	3.16 MHz
2475 MHz	3.09 MHz

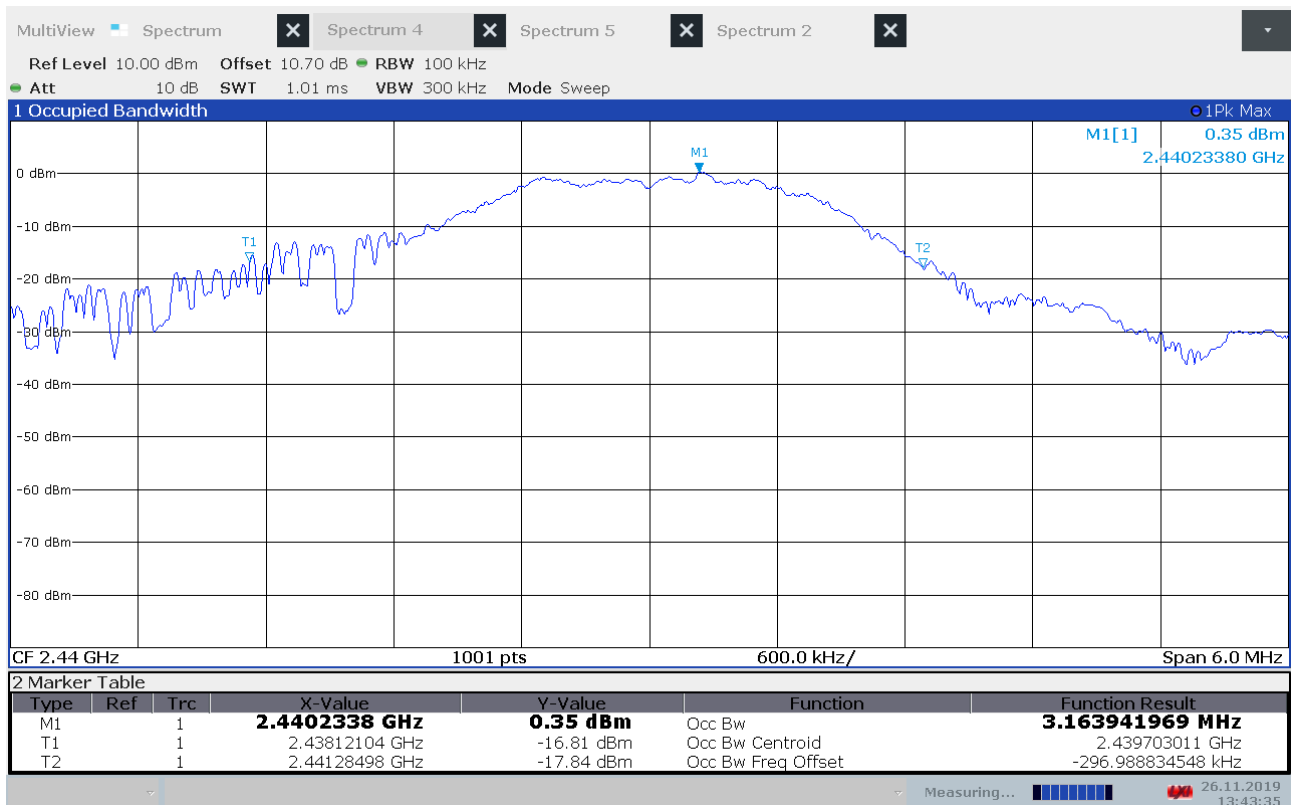
See attached plots.

Requirements:

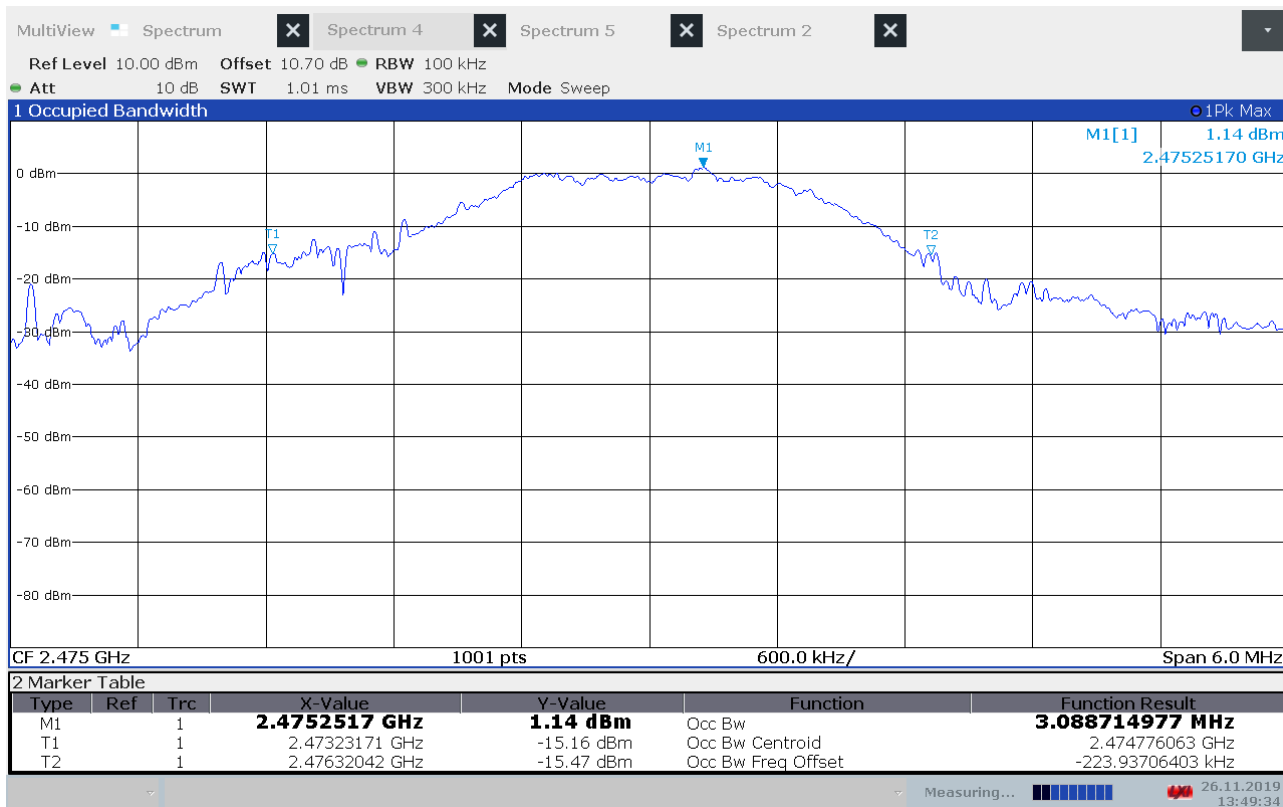
No requirement for 99% BW, reported for information only.



99% Bandwidth, 2405 MHz



99% Bandwidth, 2440 MHz



99% Bandwidth, 2475 MHz

3.2 DTS Bandwidth (6 dB BW)

FCC Part 15.247 (a)(2)

ISED Canada RSS-247 Issue 2, Clause 5.2 (a)

Measurement procedure: ANSI C63.10-2013 Clause 11.8

Test Results: Complies

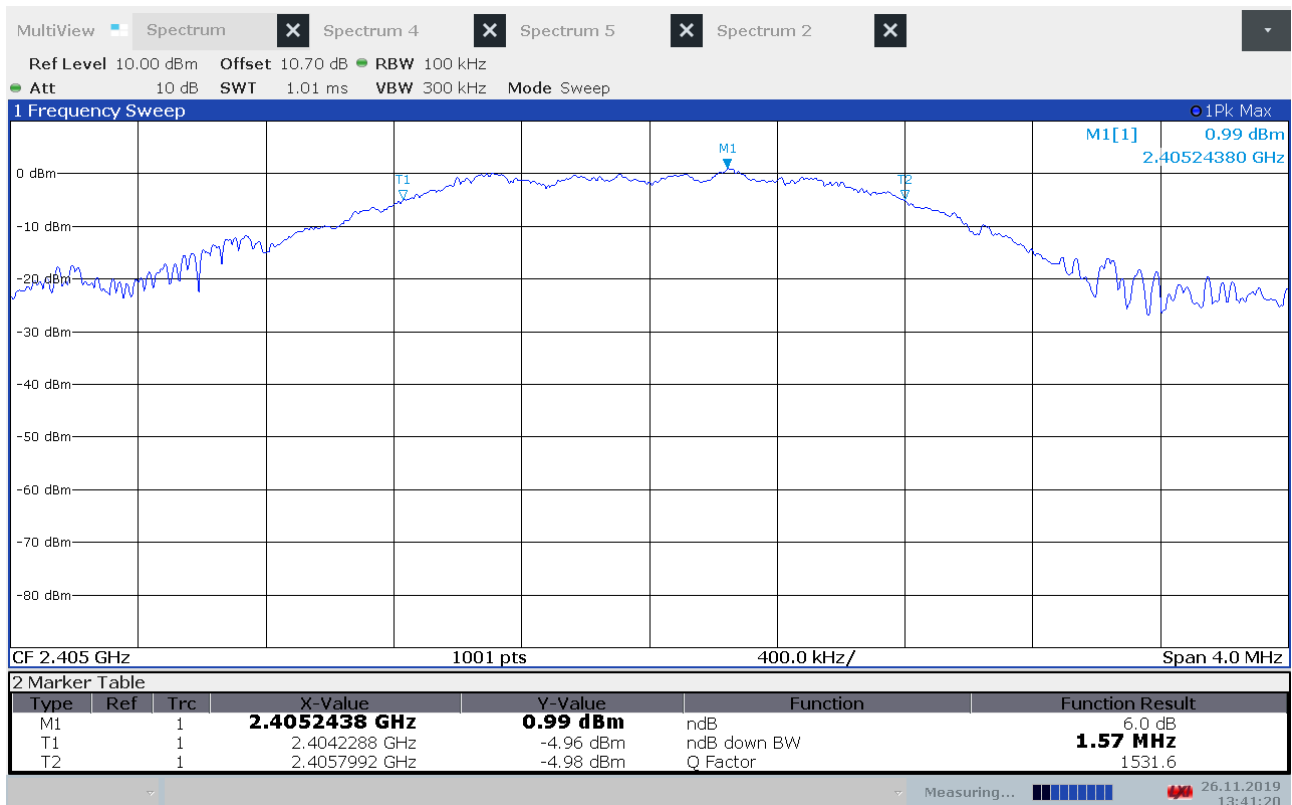
Measurement Data:

Carrier Frequency	DTS Bandwidth (6 dB BW)
2405 MHz	1.57 MHz
2440 MHz	1.60 MHz
2475 MHz	1.52 MHz

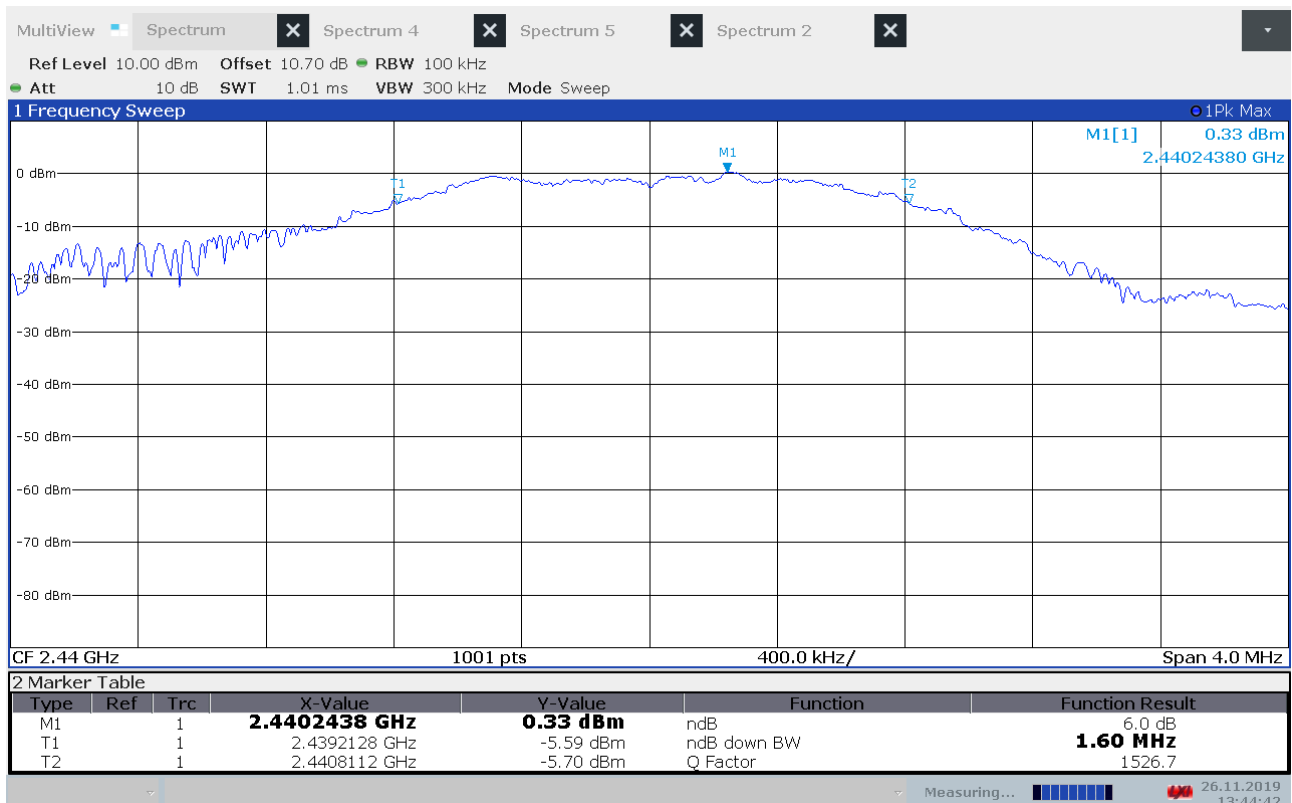
Requirements:

For Digital Transmission Systems in the 2400-2483.5 MHz band the minimum 6 dB bandwidth shall be at least 500 KHz.

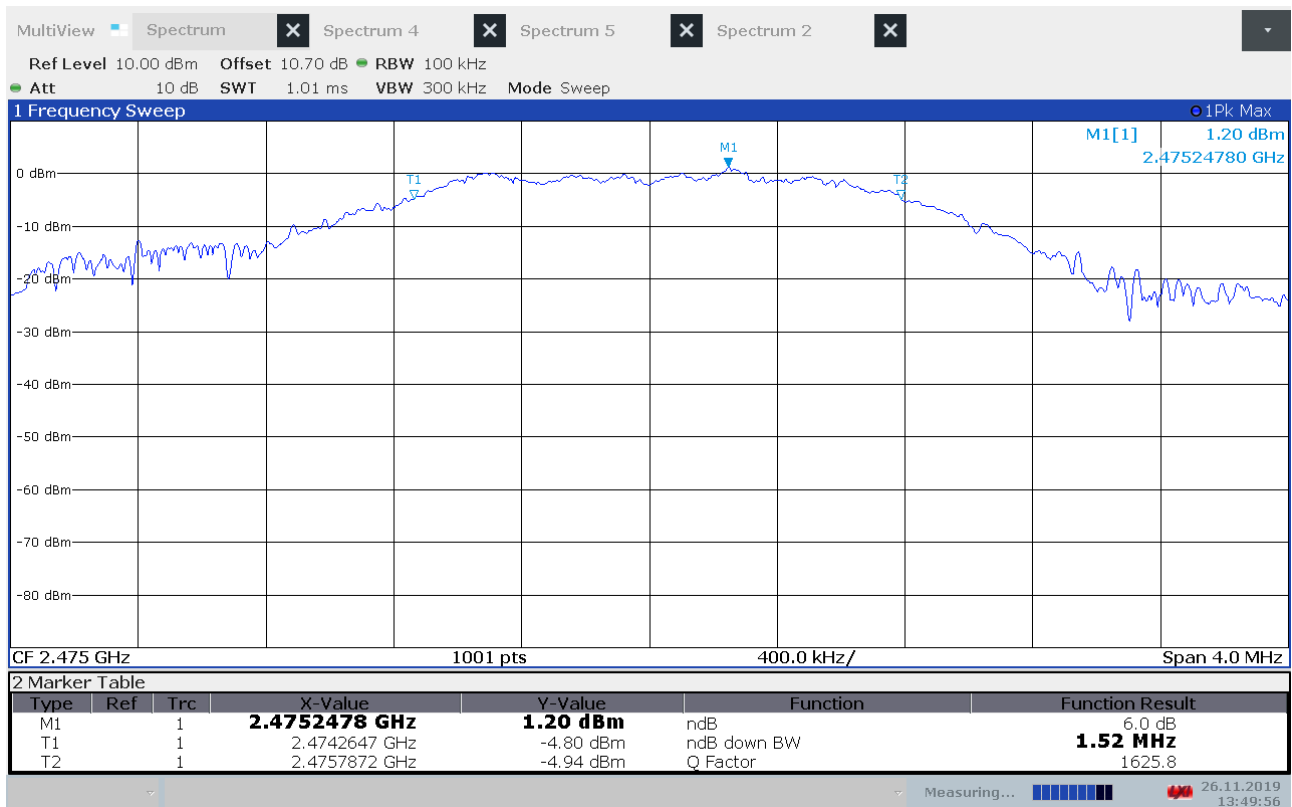
No requirements for Frequency Hopping Systems.



DTS Bandwidth, 2405 MHz



DTS Bandwidth, 2440 MHz



DTS Bandwidth, 2475 MHz

3.3 Peak Power Output

FCC Part 15.247 (b)

ISED Canada RSS-247 Issue 2, Clause 5.4

Measurement procedure: ANSI C63.10-2013 Clause 11.9.1.2

Test Results: Complies

Measurement Data:

Carrier Freq	Conducted Peak Power (dBm)	Conducted Peak Power (mW)	Field Strength (dBμV/m)	Calculated EIRP (dBm)	Calculated Antenna Gain (dBi)
2405 MHz	4.00	2.51	99.57	4.34	0.3
2440 MHz	3.41	2.19	101.25	6.02	2.6
2475 MHz	4.07	2.55	101.65	6.42	2.4

Output Power reported is Maximum Peak Power.

Radiated EIRP was calculated from measured Field Strength using the method described in FCC KDB 412172 D01.

Antenna Gain is less than 6 dBi.

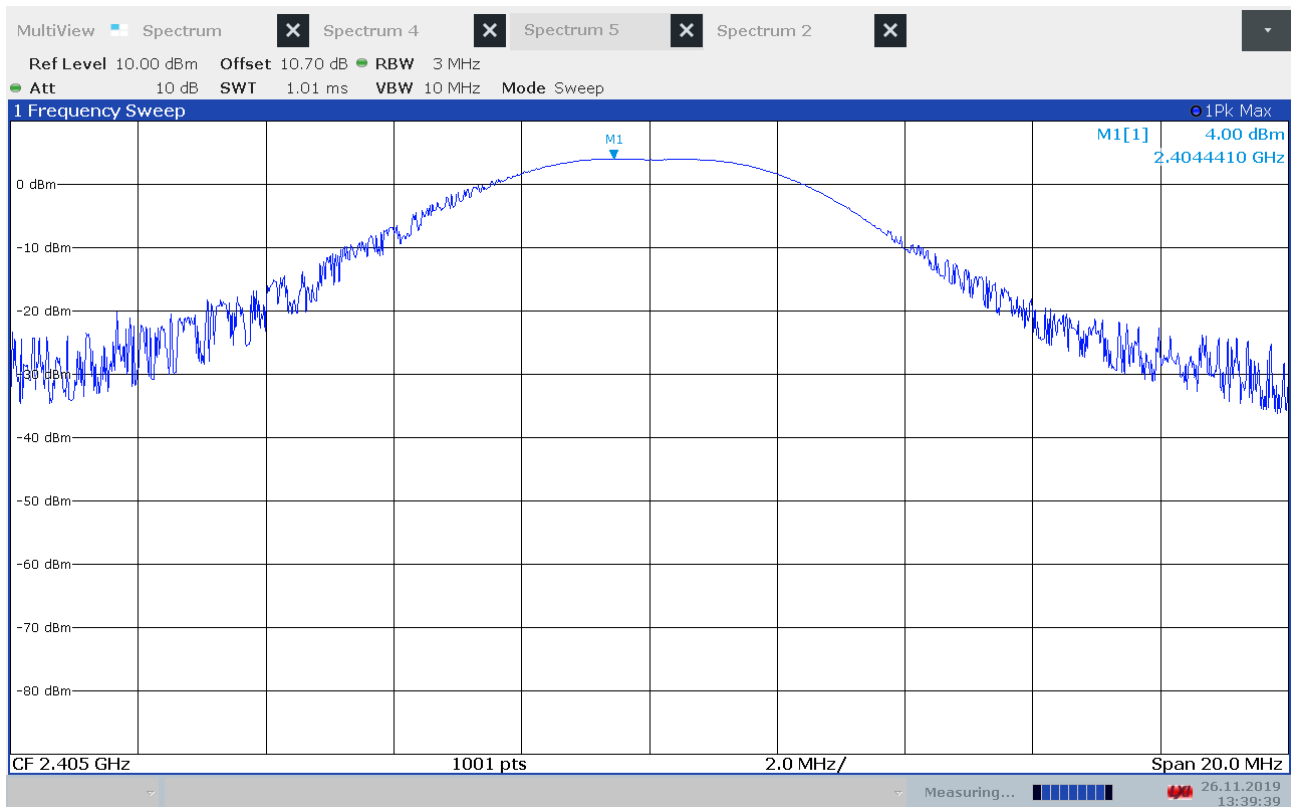
See attached plots.

Requirements:

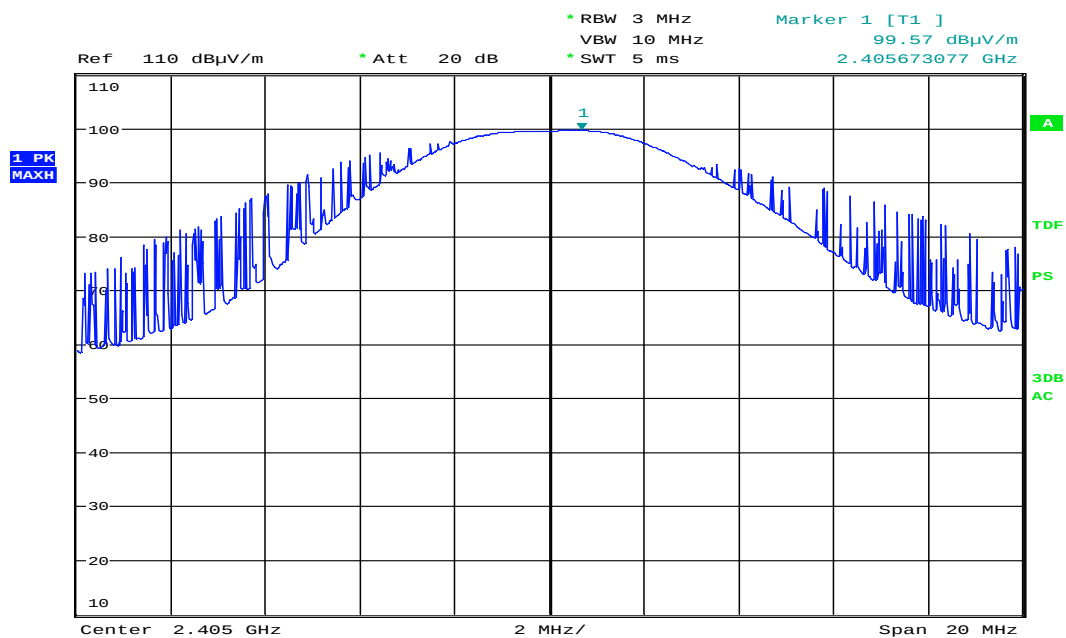
The maximum peak output power shall not exceed the following limits:

For Digital Transmission Systems in the 2400 - 2483.5 MHz band: 1 Watt

If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power from the intentional radiator shall be reduced below the stated value above by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

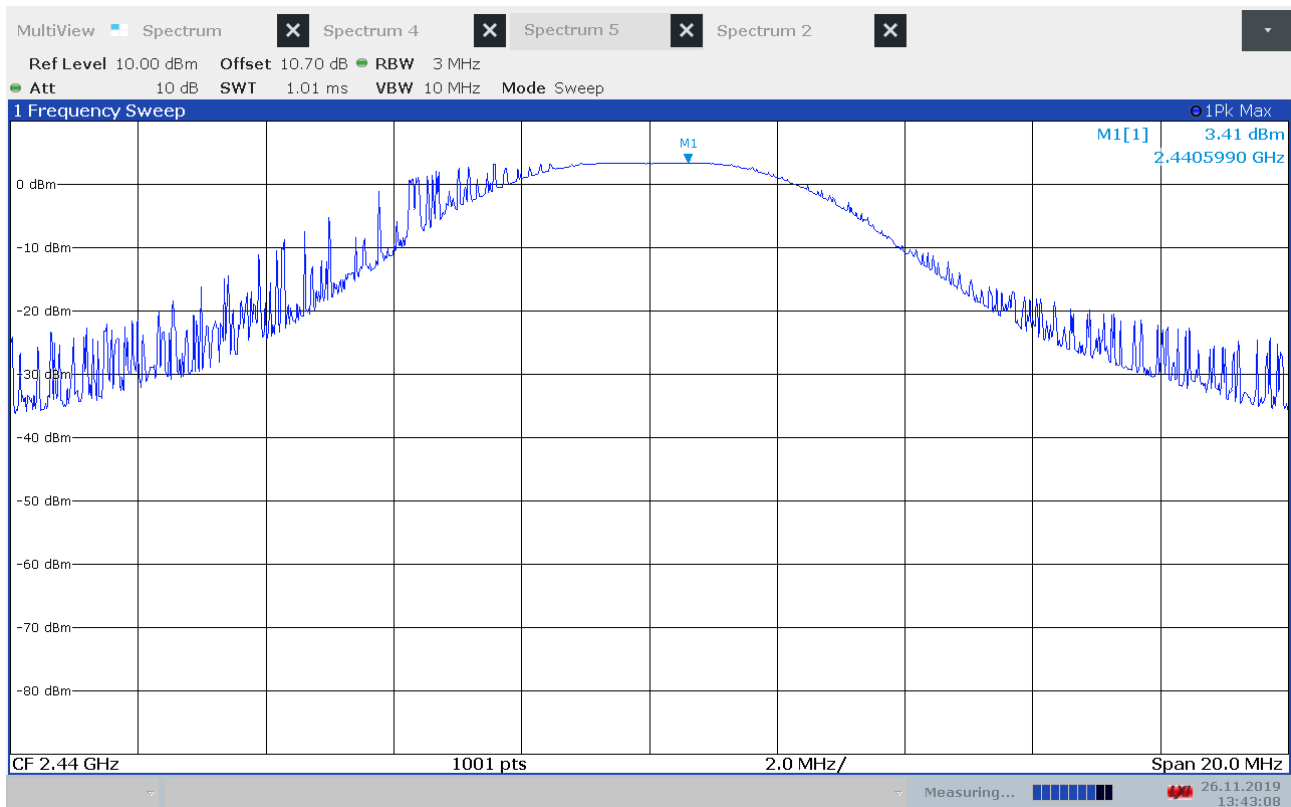


Conducted Power, 2405 MHz

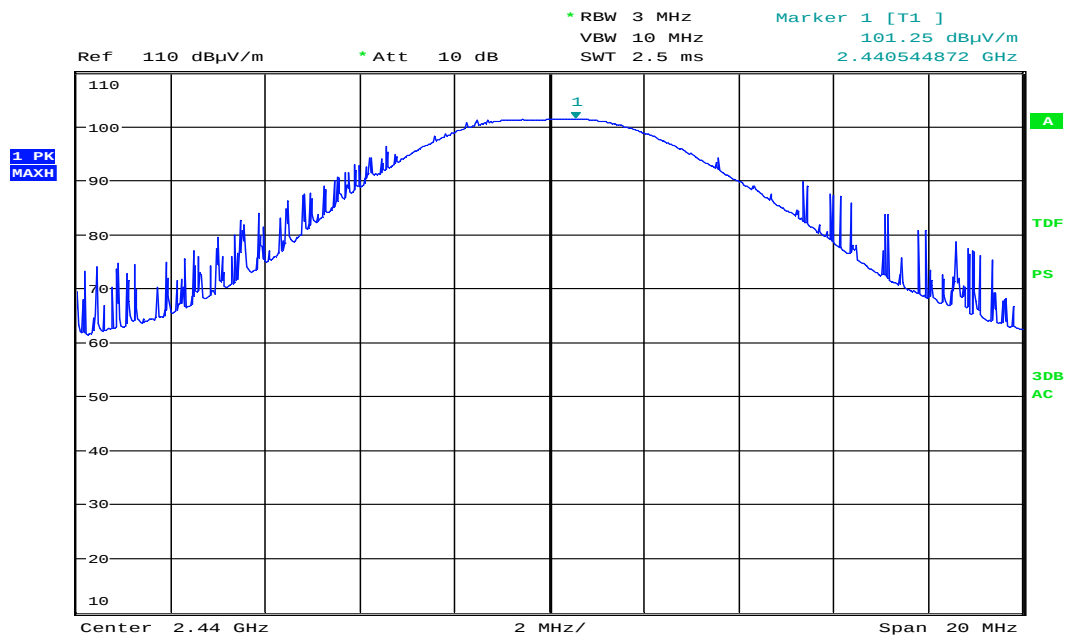


Date: 25.NOV.2019 14:26:42

Maximum Field Strength, 2405 MHz

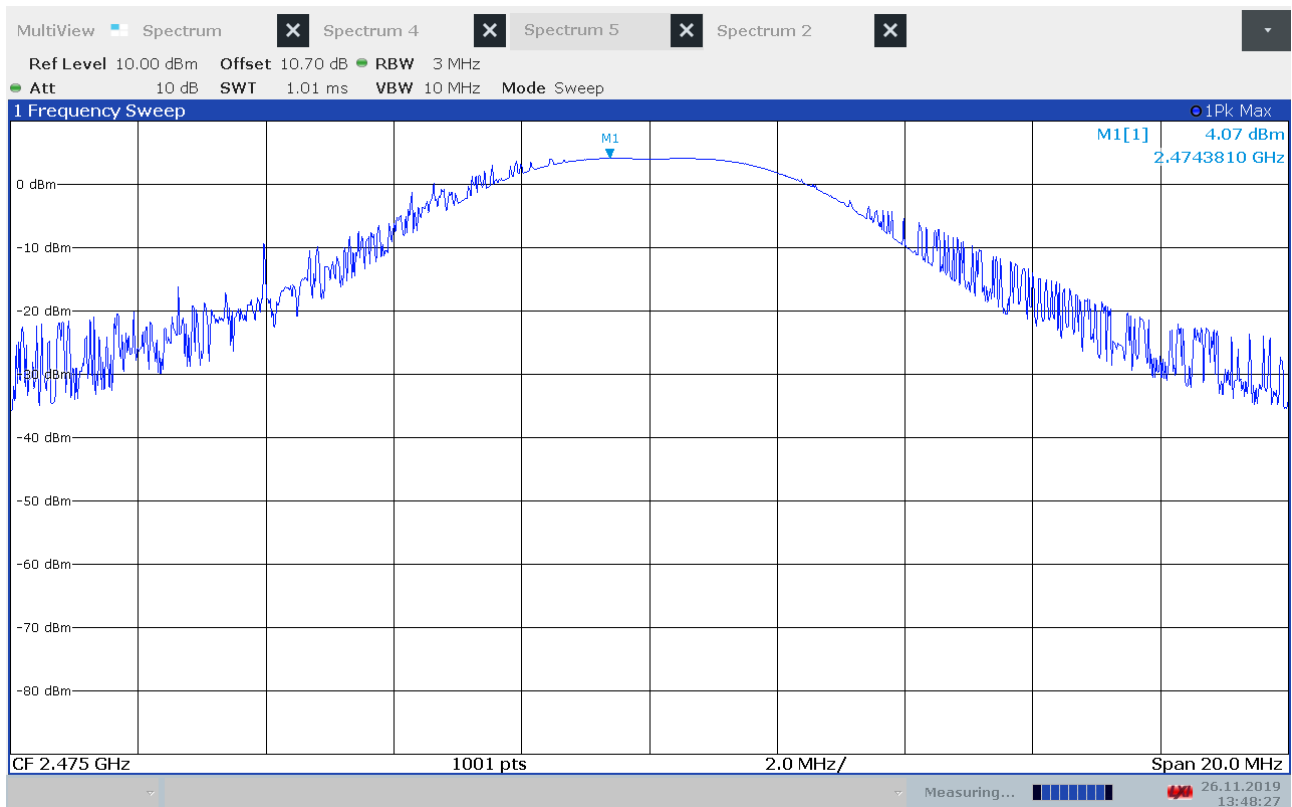


Conducted Power, 2440 MHz

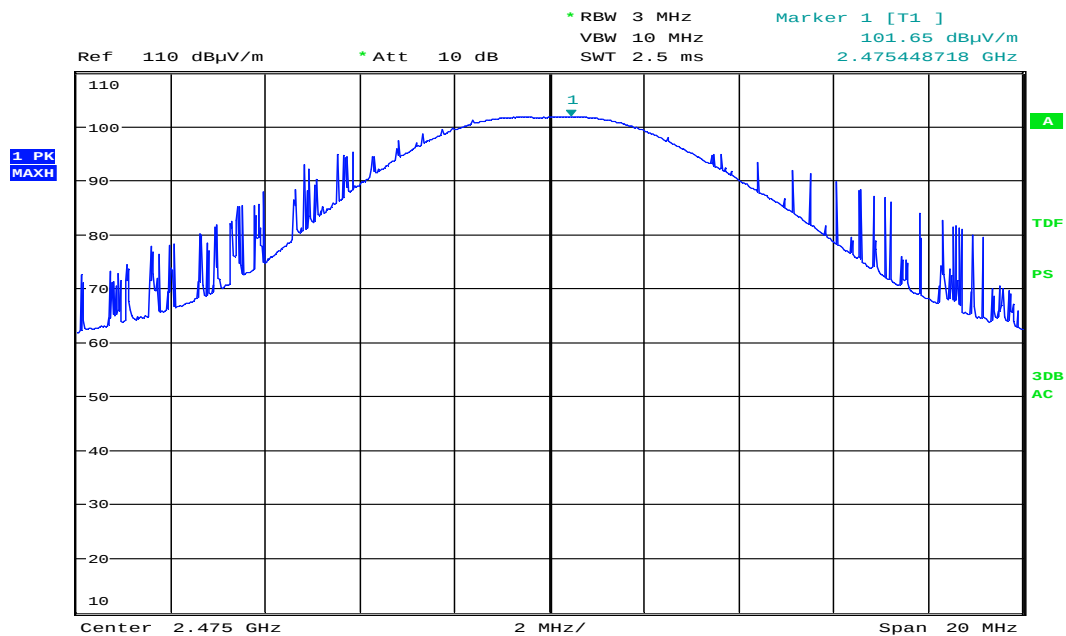


Date: 26.NOV.2019 09:37:47

Maximum Field Strength, 2440 MHz



Conducted Power, 2475 MHz



Date: 26.NOV.2019 09:58:55

Maximum Field Strength, 2475 MHz

3.4 Conducted Emissions at Antenna Connector

FCC Part 15.247 (d)

ISED Canada RSS-247 Issue 2, Clause 5.5

Measurement procedure: ANSI C63.10-2013 Clause 11.11

Test Results: Complies

Measurement Data:

Carrier Frequency	Highest Value (dBc)	Margin (dB)	Verdict
2405 MHz	>40	>20	Pass
2440 MHz	>40	>20	Pass
2475 MHz	>40	>20	Pass

Measured with Peak Detector

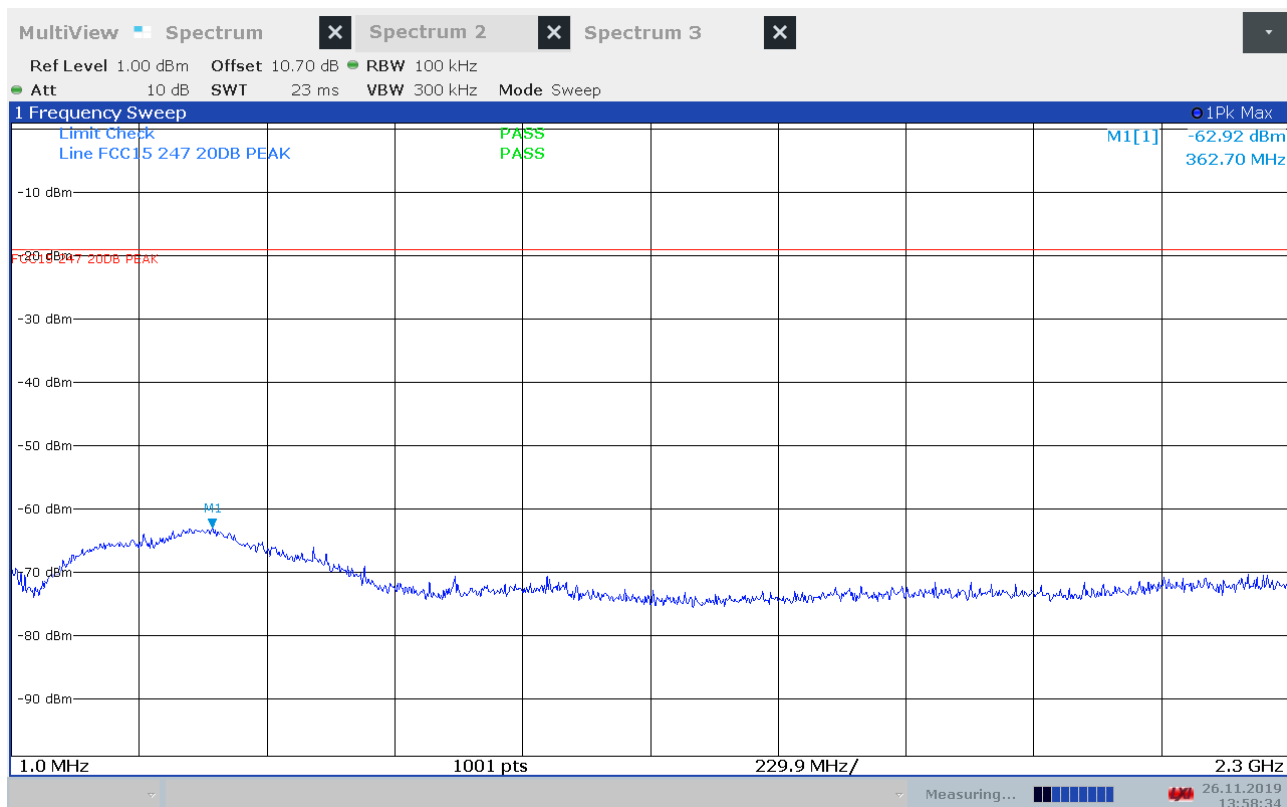
RF conducted power to 25 GHz: see attached plots.

Limit

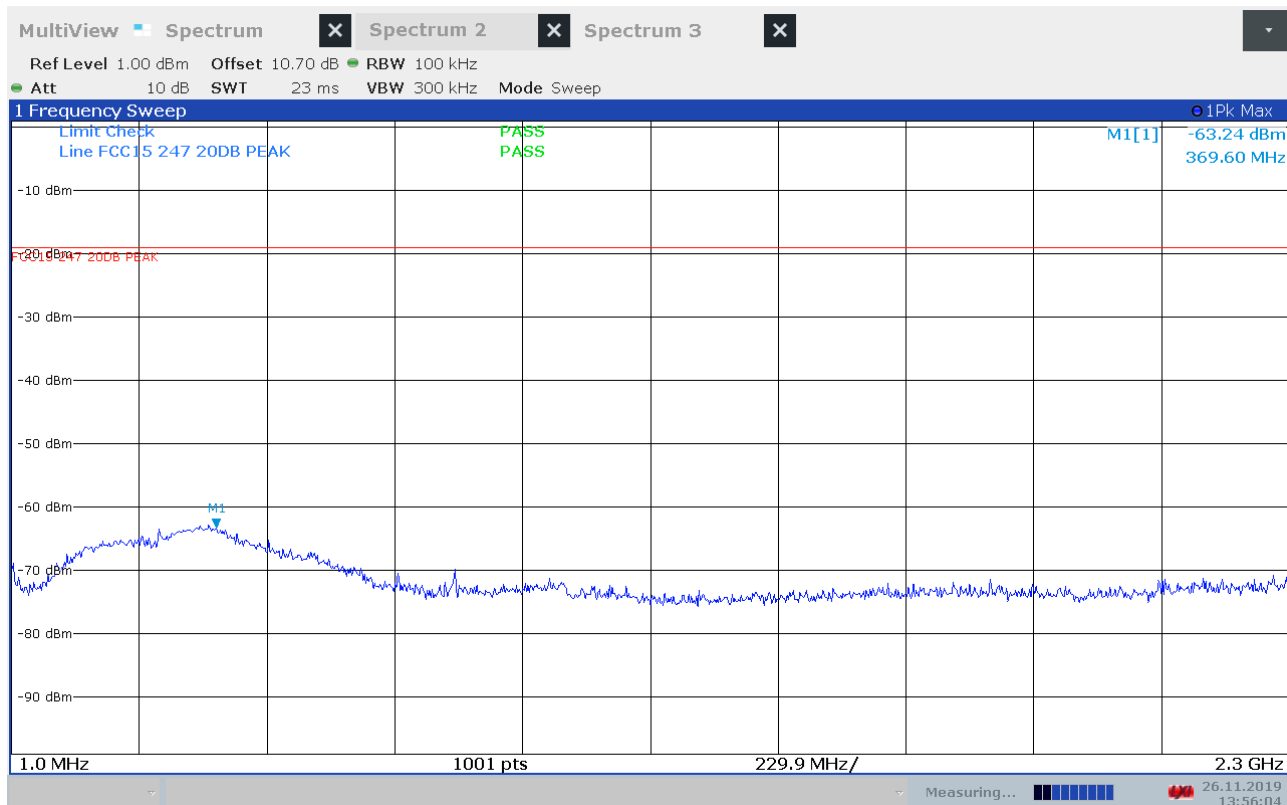
Peak measurement	RMS averaging
20 dBc or more in 100 kHz bandwidth	30 dBc or more in 100 kHz bandwidth

Detector type shall be the same as used for measuring Output Power.

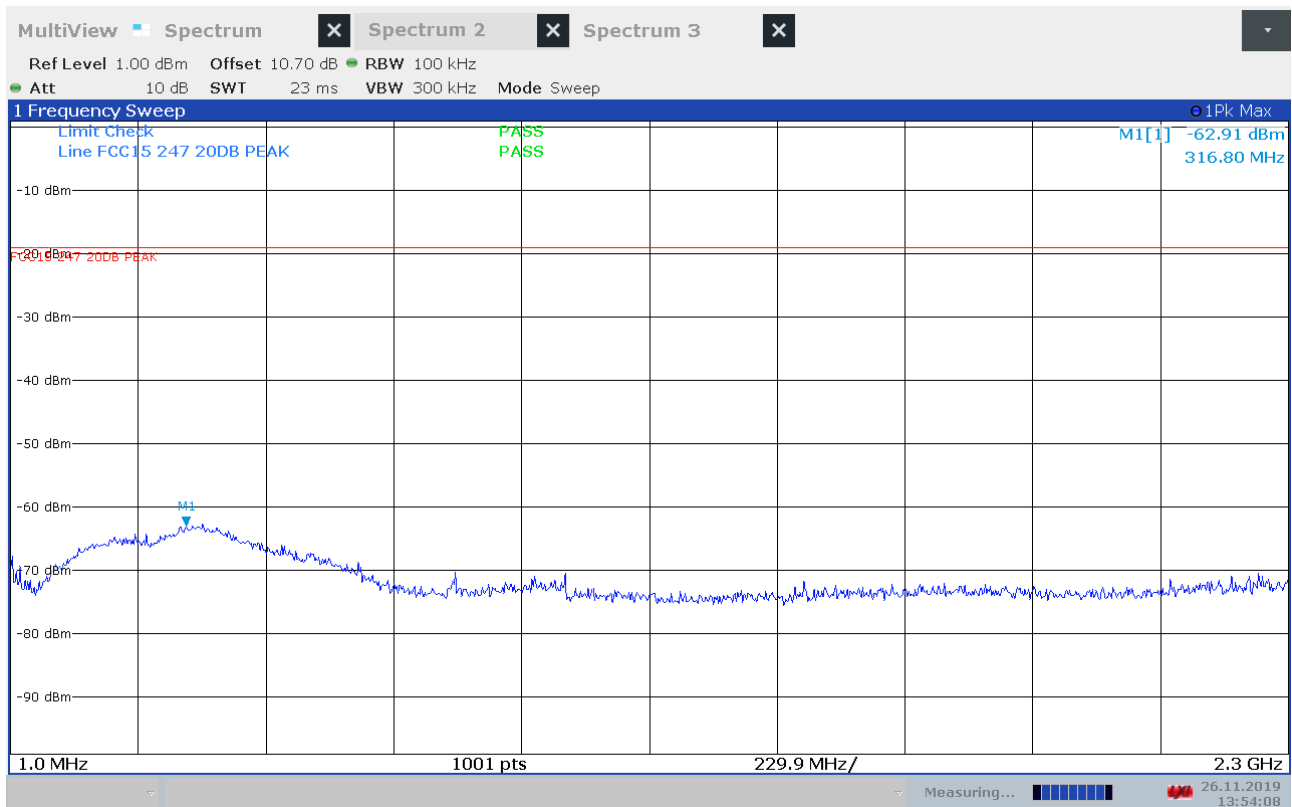
Attenuation below the general limits specified in part 15.209(a) is not required.



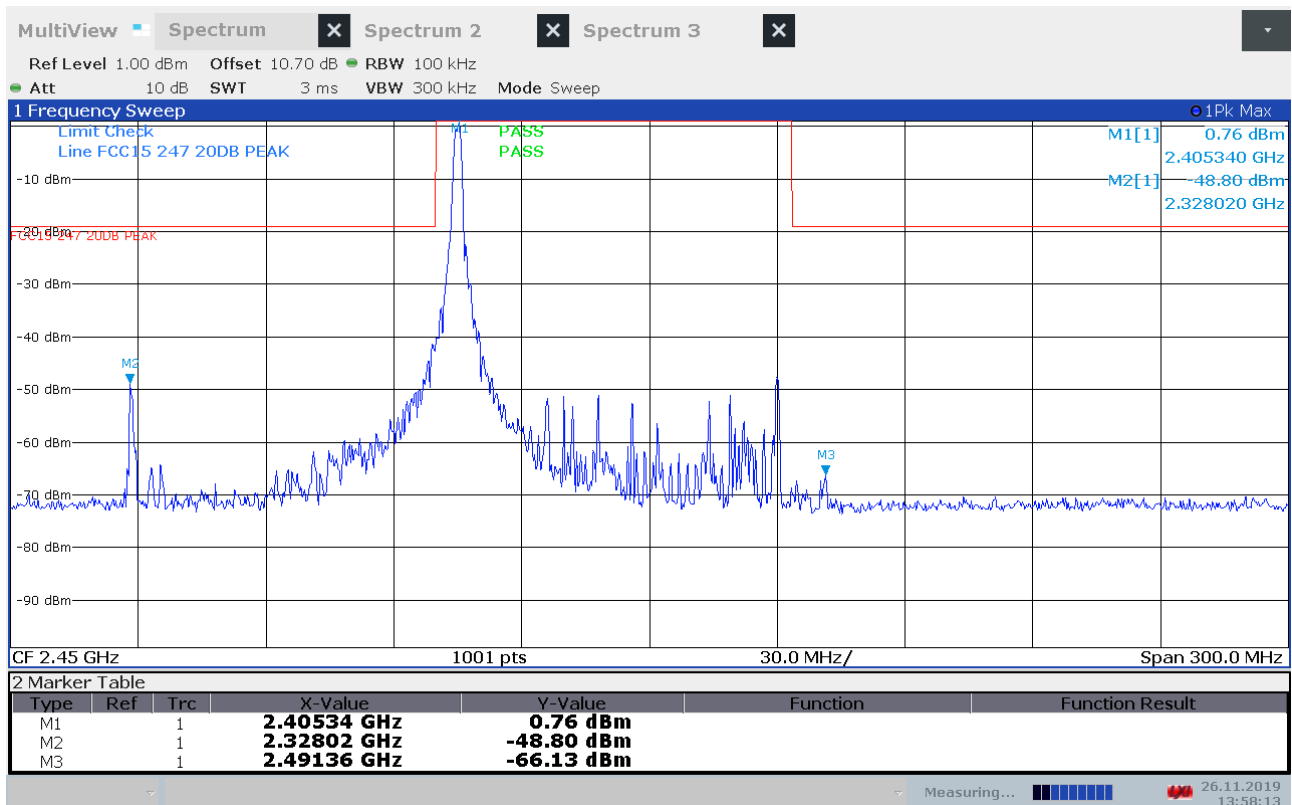
Conducted Emissions, 1 – 2300 MHz, 2405 MHz



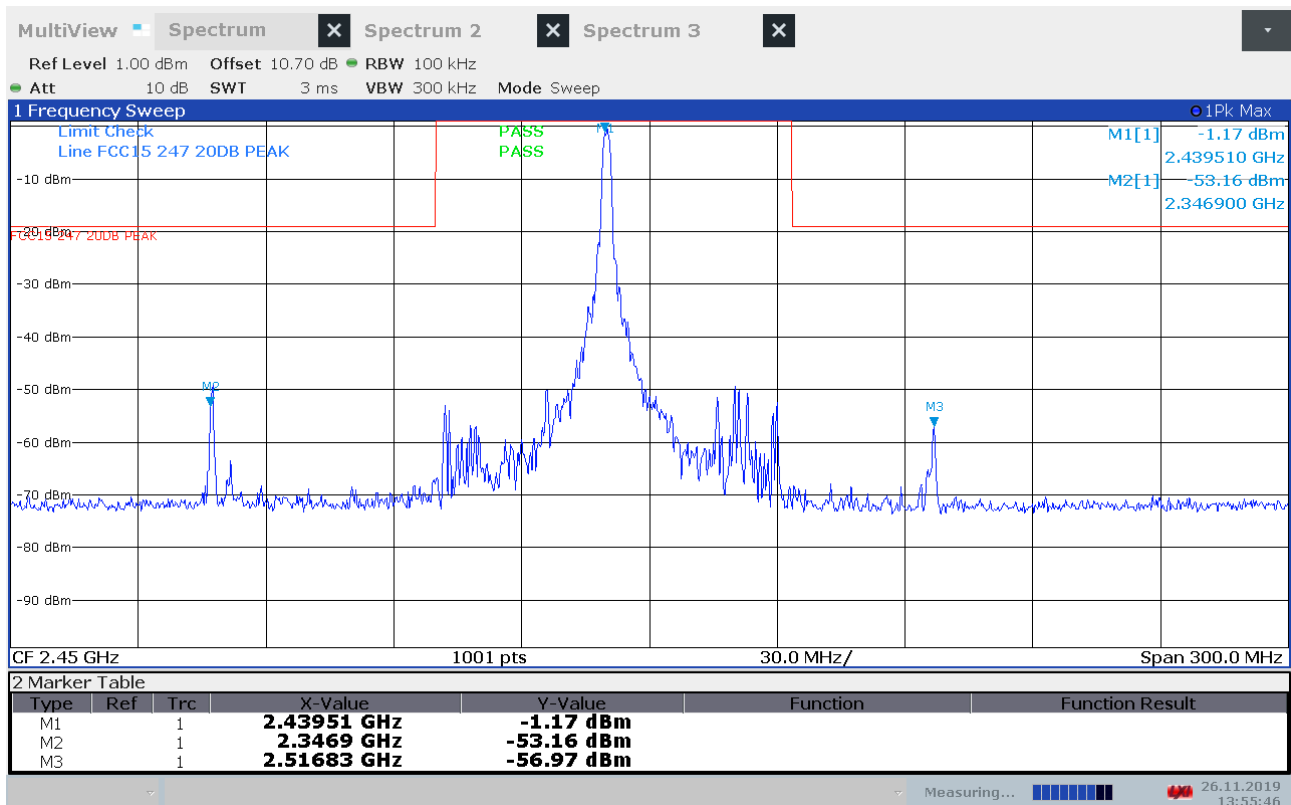
Conducted Emissions, 1 – 2300 MHz, 2440 MHz



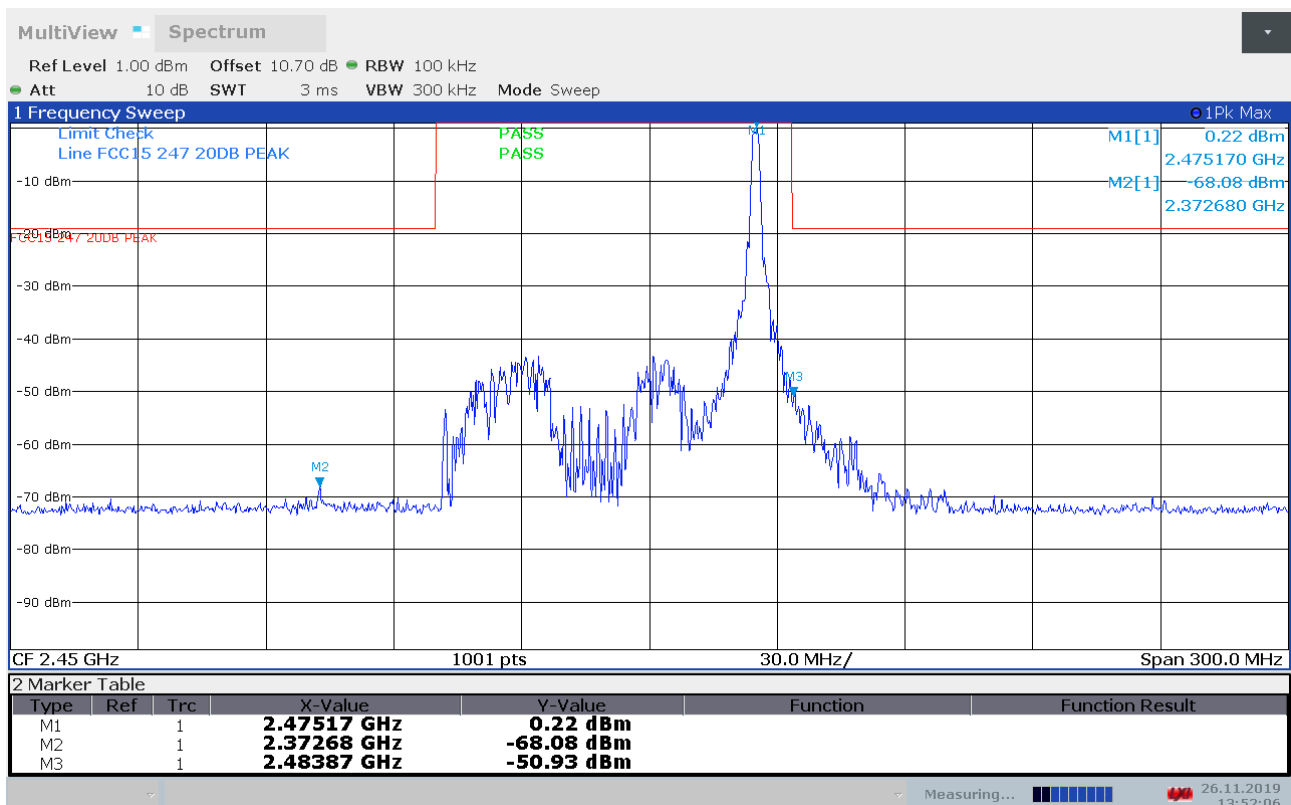
Conducted Emissions, 1 – 2300 MHz, 2475 MHz



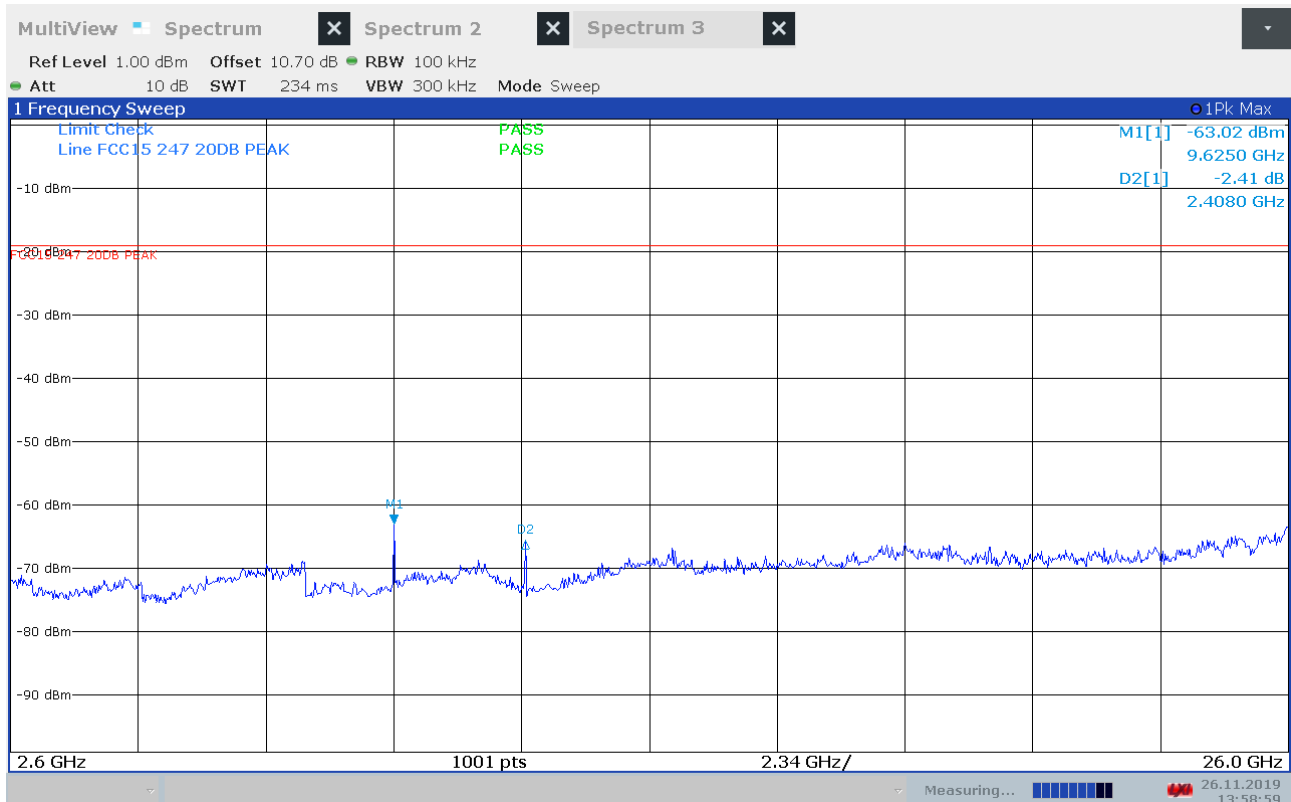
Conducted Emissions, 2300 - 2600 MHz, 2405 MHz



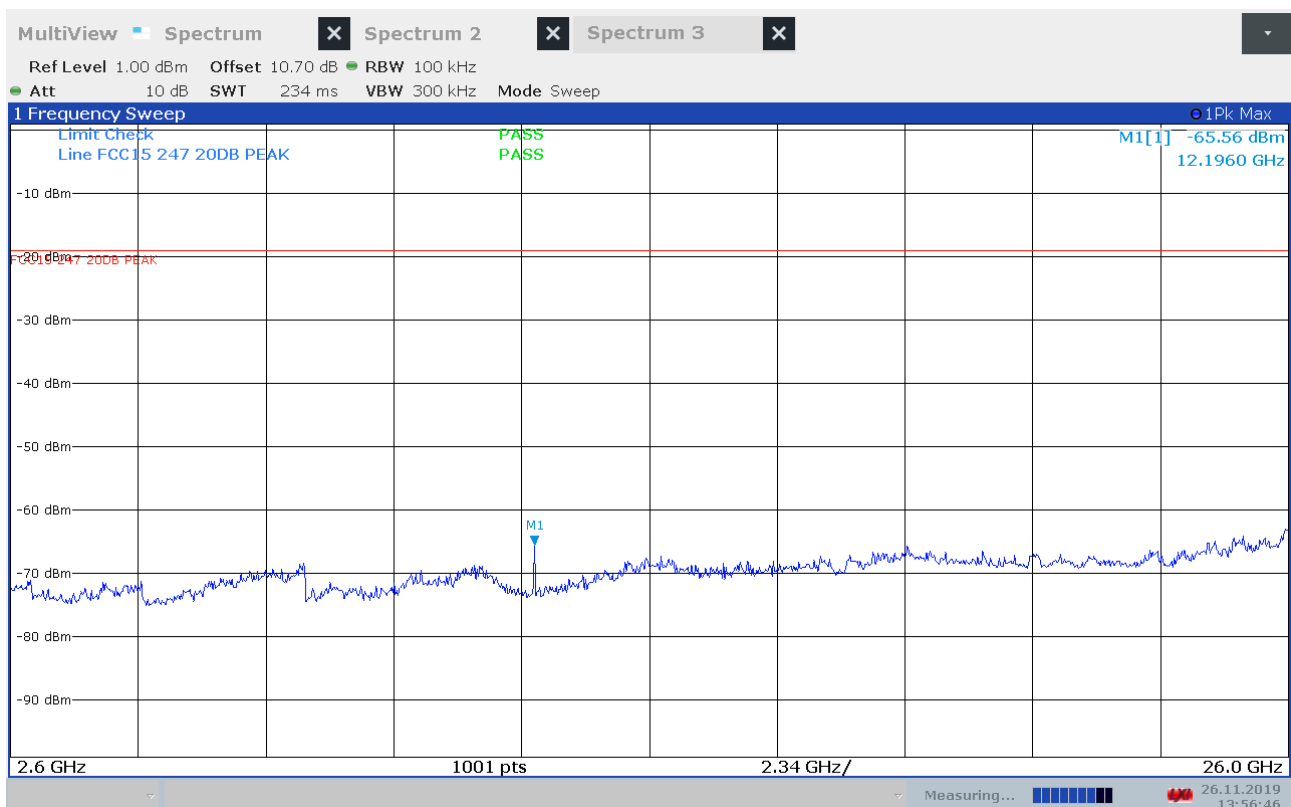
Conducted Emissions, 2300 - 2600 MHz, 2440 MHz



Conducted Emissions, 2300 - 2600 MHz, 2475 MHz



Conducted Emissions, 2600 – 26000 MHz, 2405 MHz



Conducted Emissions, 2600 – 26000 MHz, 2440 MHz



3.5 Restricted Bands of operation

Restricted Bands of operation for FCC and ISSED are defined in FCC Part 15.205 and ISSED RSS-GEN, Issue 5 clause 8.10.

Generally, no fundamentals are allowed in the restricted bands and all emissions must comply with the limits in FCC 15.209 or RSS-GEN, Issue 5, clause 8.9.

FCC (MHz)	ISSED (MHz)	FCC (GHz)	ISSED (GHz)
0.090-0.110		0.96-1.24 1.3-1.427	0.96-1.427
0.495-0.505		1.435-1.6265	
2.1735-2.1905		1.6455-1.6465	
	3.020-3.026	1.660-1.710	
4.125-4.128		1.7188-1.7222	
4.17725-4.17775		2.2-2.3	
4.20725-4.20775		2.31-2.39	
	5.677-5.683	2.4835-2.5	
6.215-6.218		2.69-2.9	2.655-2.9
6.26775-6.26825		3.26-3.267	
6.31175-6.31225		3.332-3.339	
8.291-8.294		3.3458-3.358	
8.362-8.366		3.6-4.4	3.5-4.4
8.37625-8.38675		4.5-5.15	
8.41425-8.41475		5.35-5.46	
12.29-12.293		7.25-7.75	
12.51975-12.52025		8.025-8.5	
12.57675-12.57725		9.0-9.2	
13.36-13.41		9.3-9.5	
16.42-16.423		10.6-12.7	
16.69475-16.69525		13.25-13.4	
16.80425-16.80475		14.47-14.5	
25.5-25.67		15.35-16.2	
37.5-38.25		17.7-21.4	
73-74.6		22.01-23.12	
74.8-75.2		23.6-24.0	
108-121.94 123-138	108-138	31.2-31.8	
149.9-150.05		36.43-36.5	
156.52475-156.52525		Above 38.6	
156.7-156.9			
162.0125-167.17			
167.72-173.2			
240-285			
322-335.4			
399.9-410			
608-614			

Frequencies in **Bold** text are specific for FCC or ISSED, all other frequencies are common.

3.6 Radiated Emissions, Band Edge

FCC Part 15.209 (a)

ISED Canada RSS-GEN Issue 5, Clause 7.3 / 8.9

Measurement procedure: ANSI C63.10-2013 Clause 11.12

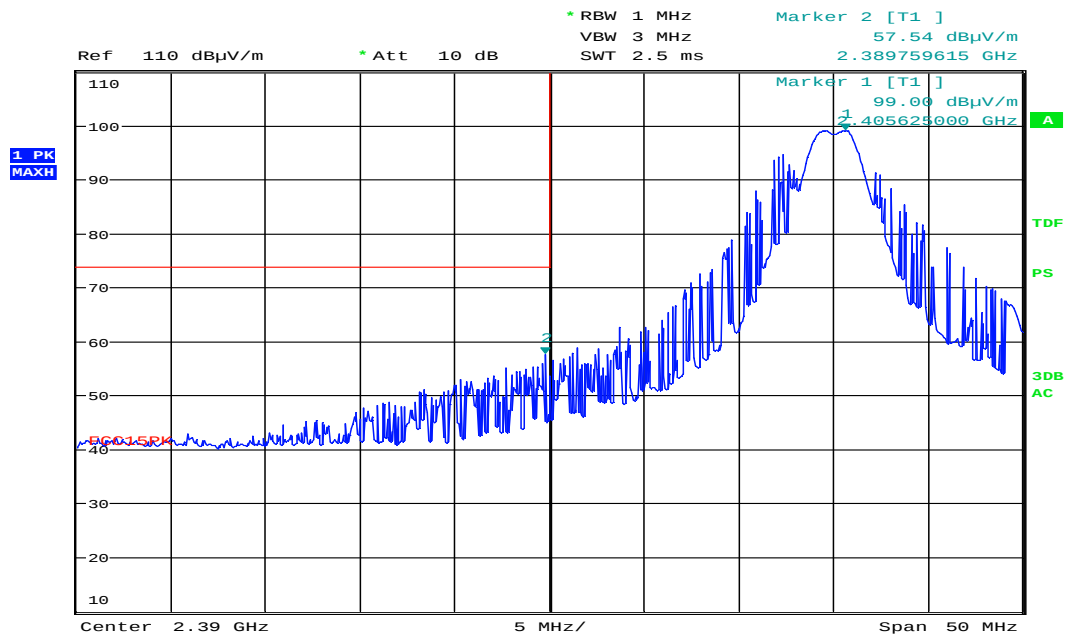
Test Results: Complies

Measurement Data:

Detector	Measured field strength (dB μ V/m)		Limit	Margin	
	2390 MHz	2483.5 MHz	dB μ V/m	dB	
Peak	57.5	70.7	74	16.5	3.3
Average	37.5	50.7	54	16.5	3.3

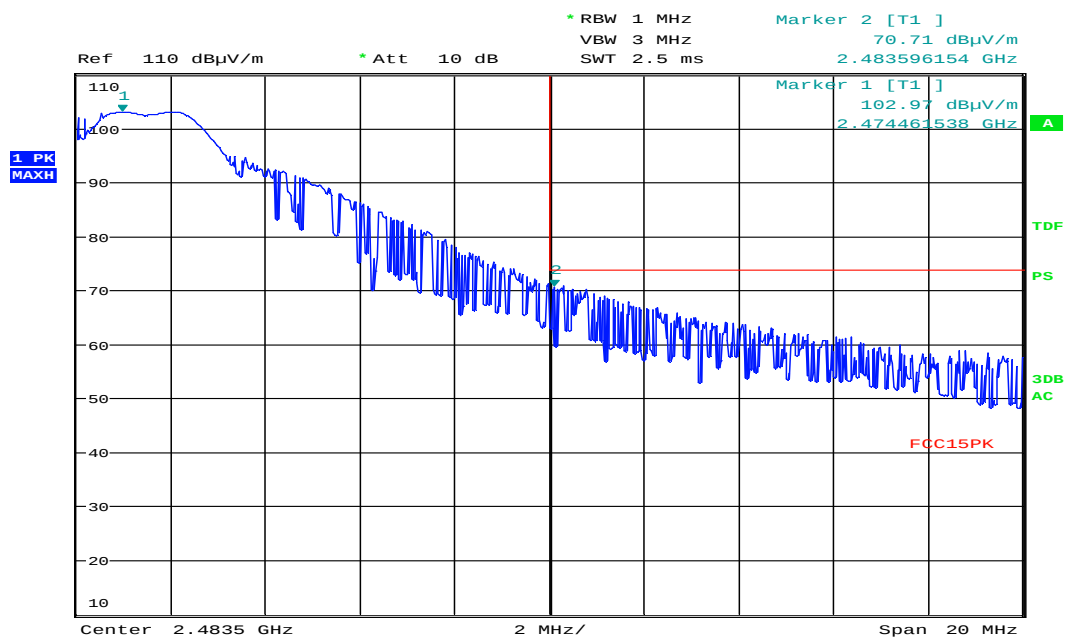
Average Detector values are measured with Peak Detector and corrected for Duty Cycle.

See attached plots.



Date: 26.NOV.2019 09:29:14

Lower Band Edge, 2405 MHz



Date: 26.NOV.2019 09:31:52

Upper Band Edge, 2475 MHz

3.7 Radiated Emission, 30 – 1000 MHz.

FCC Part 15.209 (a)

ISED Canada RSS-GEN Issue 5, Clause 7.3/8.9

Measurement procedure: ANSI C63.10-2013 Clause 11.12

Test Results: Complies

Measurement Data:

Detector: Peak

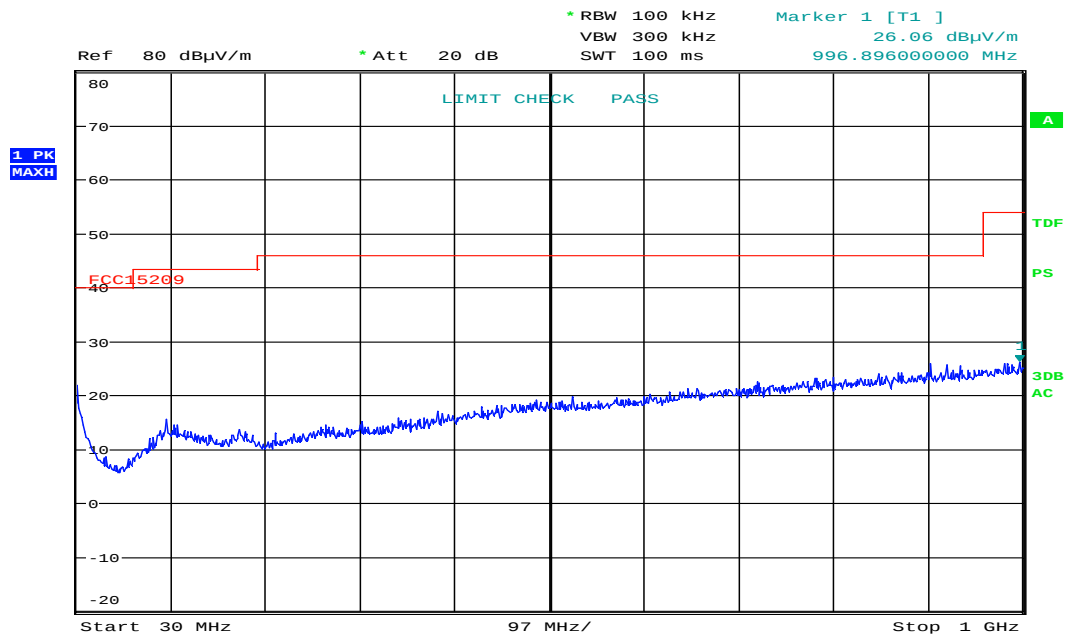
Measuring distance 3m

No spurious emissions were detected.

See attached plots

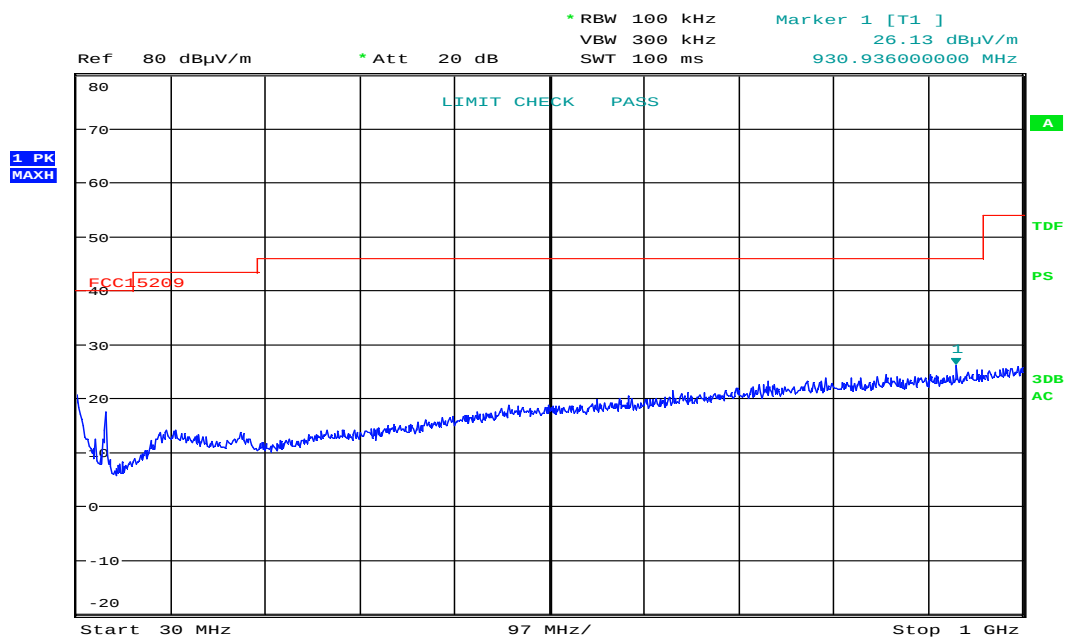
Requirements/Limit

FCC	Part 15.209 @ frequencies defined in §15.205	
ISED	RSS-GEN Issue 5, Clause 8.9 @ frequencies defined in clause 8.10	
Frequency	Radiated emission limit @3 meters	
30 – 88 MHz	100 $\mu\text{V/m}$	40.0 dB $\mu\text{V/m}$
88 – 216 MHz	150 $\mu\text{V/m}$	43.5 dB $\mu\text{V/m}$
216 – 960 MHz	200 $\mu\text{V/m}$	46.0 dB $\mu\text{V/m}$
960 – 1000 MHz	500 $\mu\text{V/m}$	54.0 dB $\mu\text{V/m}$
Limits above are with Quasi Peak Detector		



Date: 25.NOV.2019 13:40:36

Radiated Emissions, 30 – 1000 MHz, HP



Date: 25.NOV.2019 13:38:31

Radiated Emissions, 30 – 1000 MHz, VP

3.8 Radiated Emissions, 1-26 GHz

FCC Part 15.209 (a)

ISED Canada RSS-GEN Issue 5, Clause 7.3/8.9

Measurement procedure: ANSI C63.10-2013 Clause 11.12

Test Results: Complies

Measurement Data:

Measuring distance: 3m (1 – 18 GHz)
1m (18 – 26 GHz)

No spurious emissions were detected.

Average Detector values are calculated from Peak values by Duty Cycle Correction Factor.

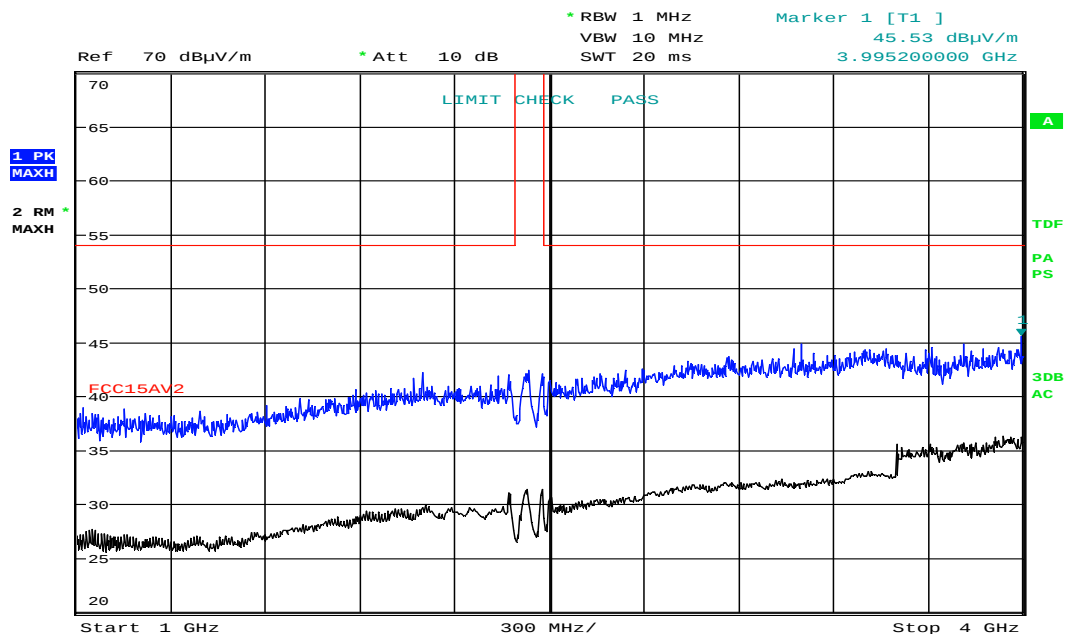
A Band Reject Filter was used for measurements from 1 GHz to 4 GHz and a High Pass Filter was used from 3 GHz to 18 GHz.

Antenna factor, amplifier gain and cable loss are included in spectrum analyzer "Transducer factor".

See plots.

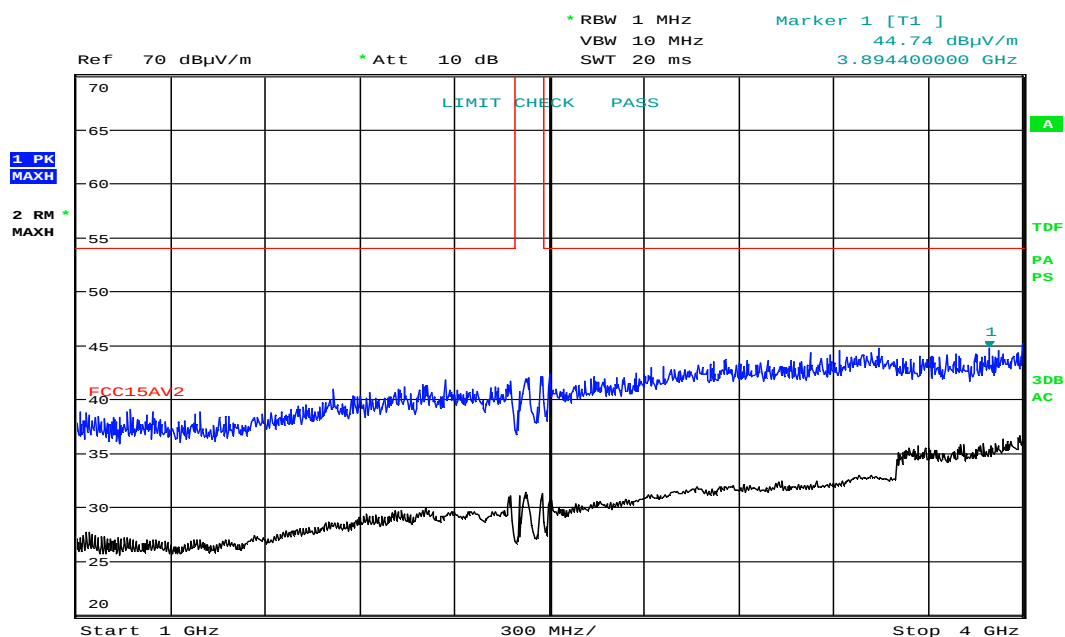
Requirements/Limit

FCC	Part 15.209 @ frequencies defined in §15.205	
ISED	RSS-GEN Issue 5, clause 8.9 @ frequencies defined in clause 8.10	
	Radiated emission limit @3 meters	
Frequency	Average Detector	Peak Detector
1 – 26 GHz	54.0 dBµV/m	74.0 dBµV/m



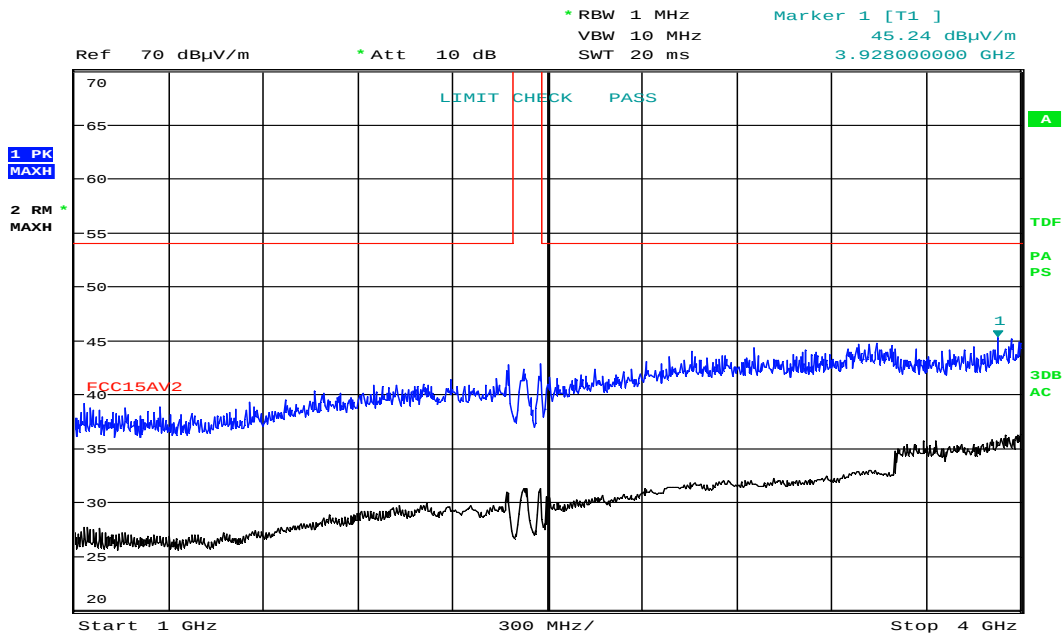
Date: 25.NOV.2019 15:27:49

Radiated Emissions, 1 – 4 GHz, 2405MHz, HP



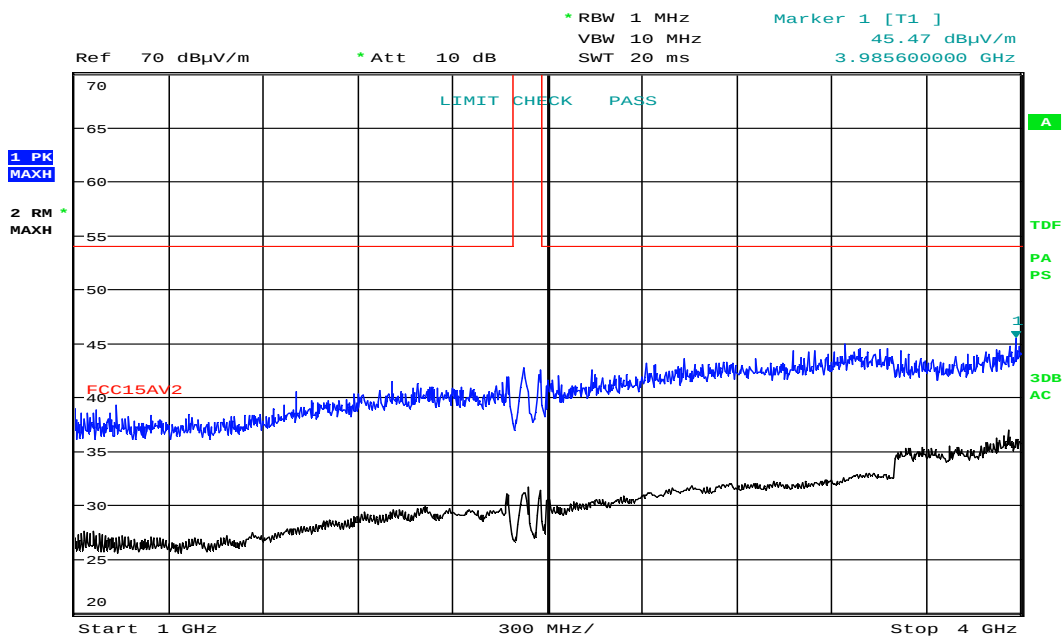
Date: 25.NOV.2019 15:25:53

Radiated Emissions, 1 – 4 GHz, 2405MHz, VP



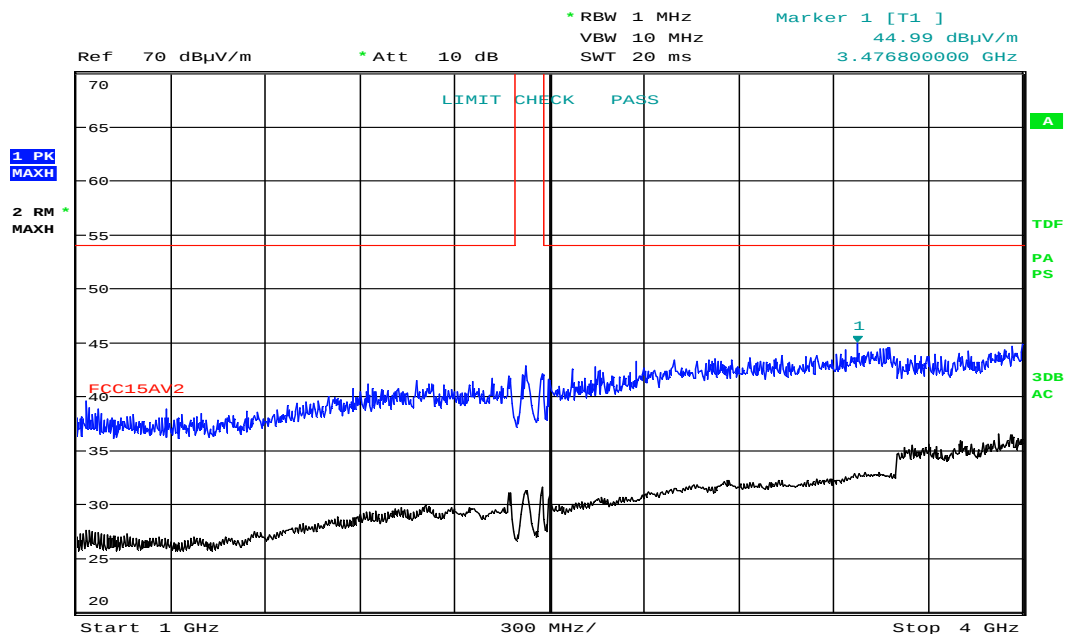
Date: 25.NOV.2019 14:49:43

Radiated Emissions, 1 – 4 GHz, 2440MHz, HP



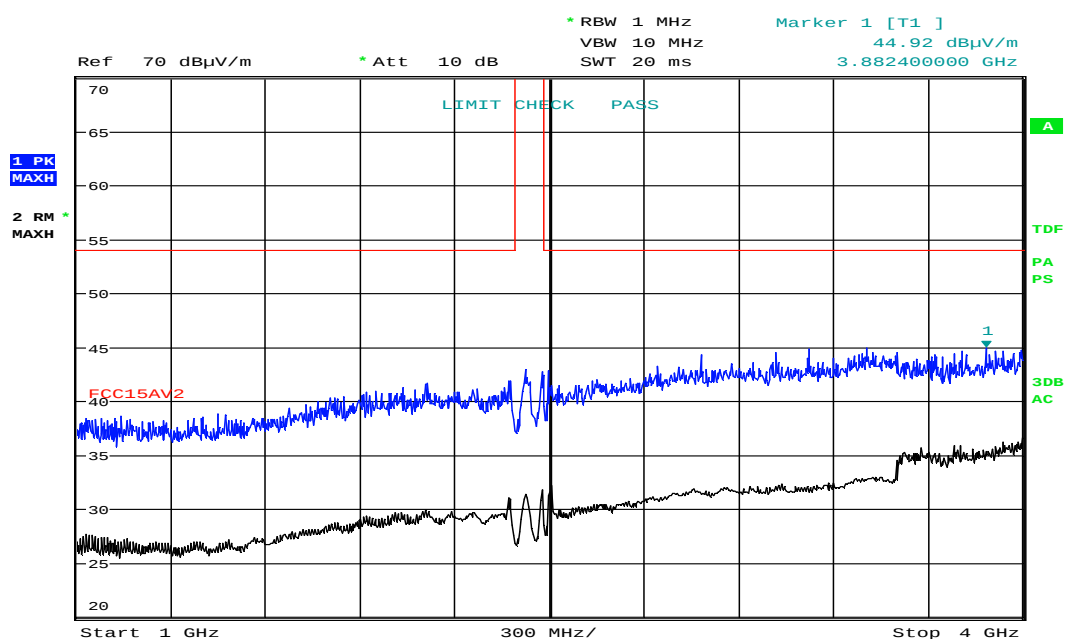
Date: 25.NOV.2019 14:47:47

Radiated Emissions, 1 – 4 GHz, 2440MHz, VP



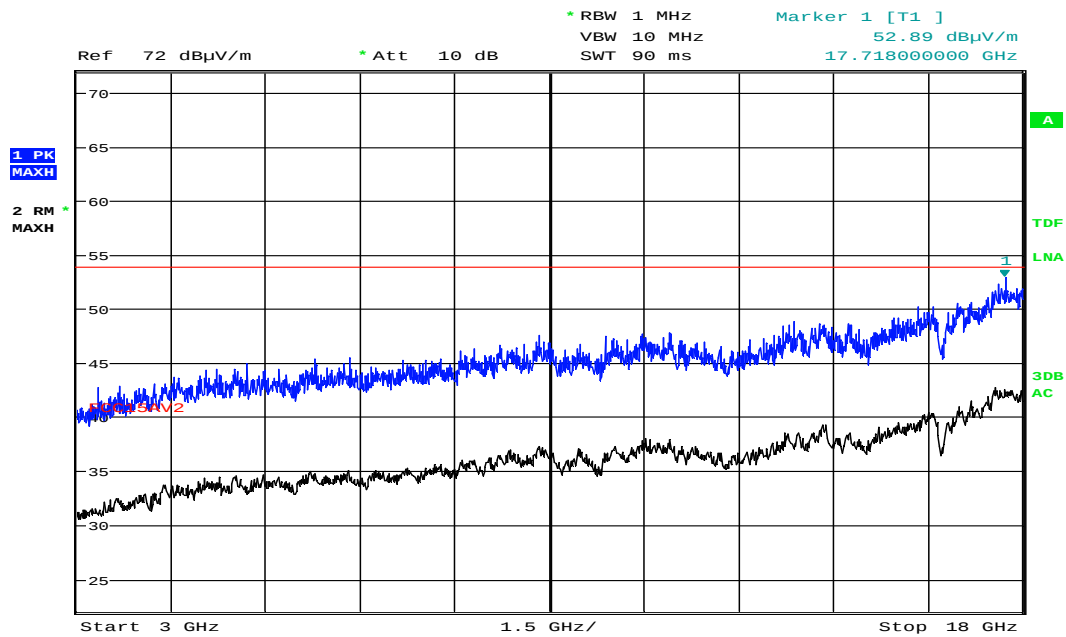
Date: 25.NOV.2019 15:08:29

Radiated Emissions, 1 – 4 GHz, 2475MHz, HP



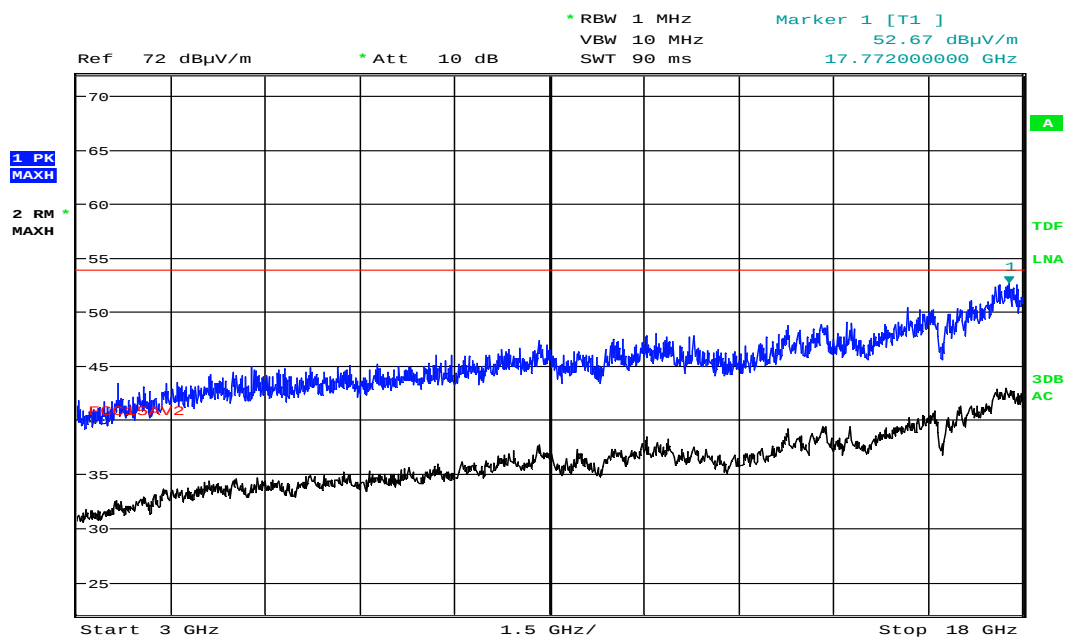
Date: 25.NOV.2019 15:06:33

Radiated Emissions, 1 – 4 GHz, 2475MHz, VP



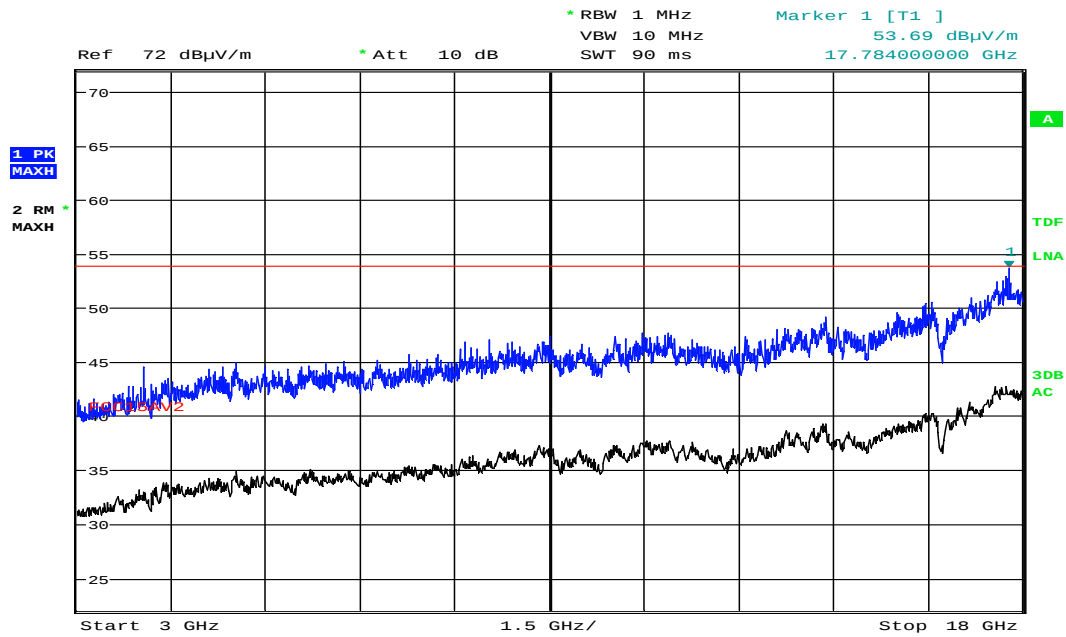
Date: 25.NOV.2019 16:22:55

Radiated Emissions, 3 – 18 GHz, 2405MHz, HP



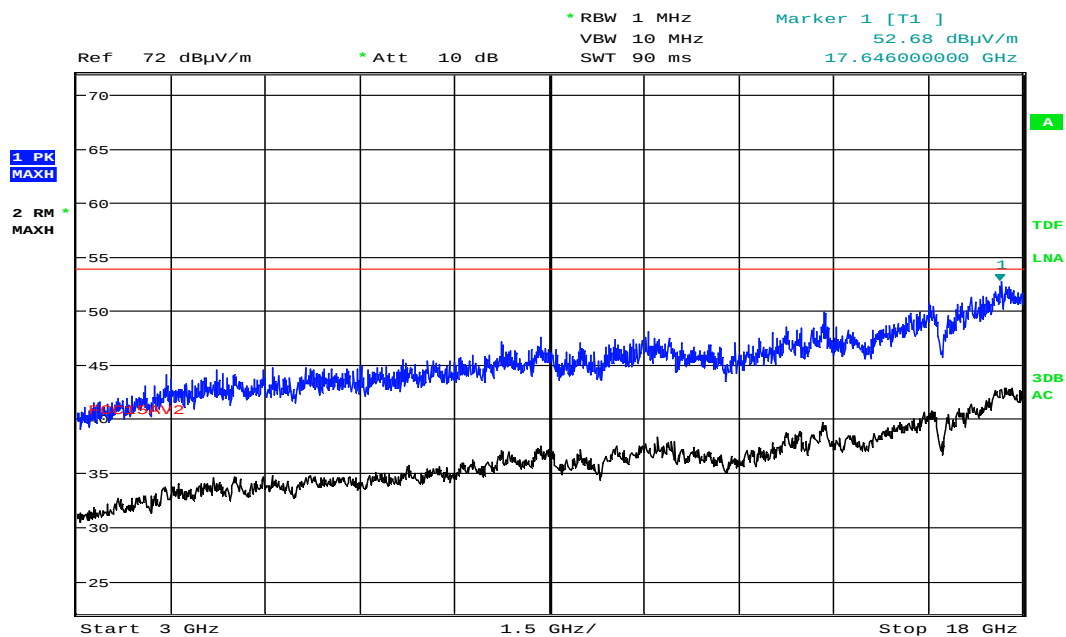
Date: 25.NOV.2019 16:20:59

Radiated Emissions, 3 – 18 GHz, 2405MHz, VP



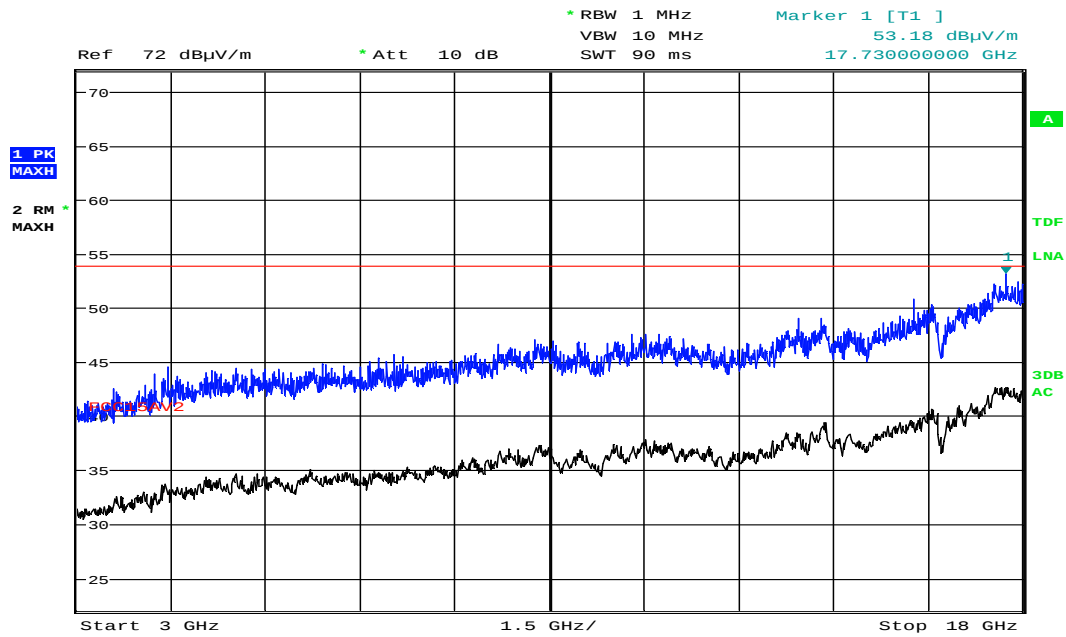
Date: 25.NOV.2019 16:16:12

Radiated Emissions, 3 – 18 GHz, 2440MHz, HP



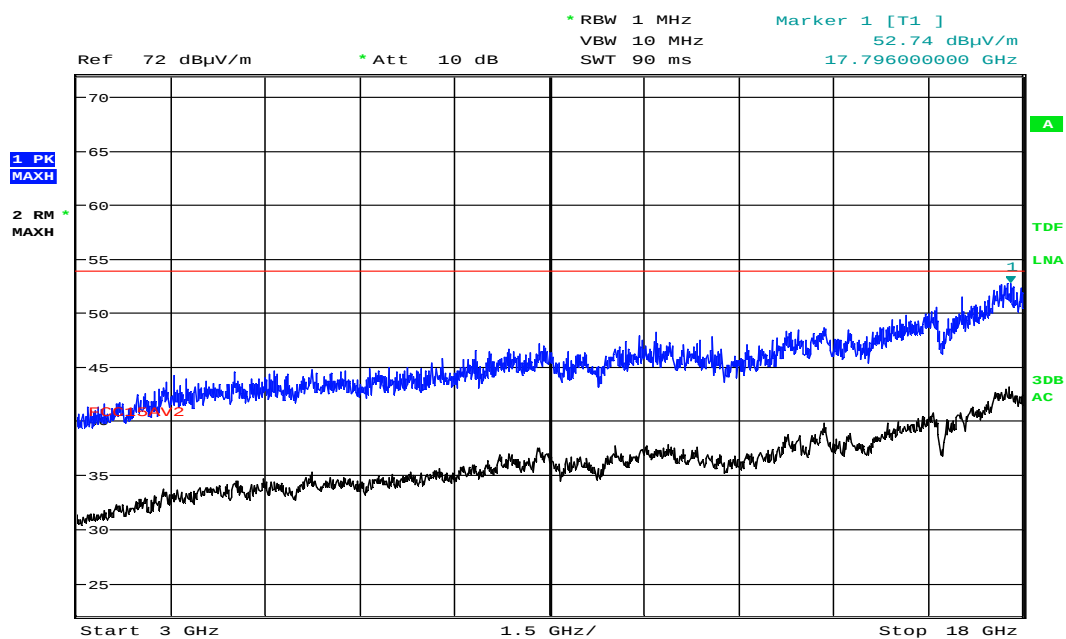
Date: 25.NOV.2019 16:14:16

Radiated Emissions, 3 – 18 GHz, 2440MHz, VP



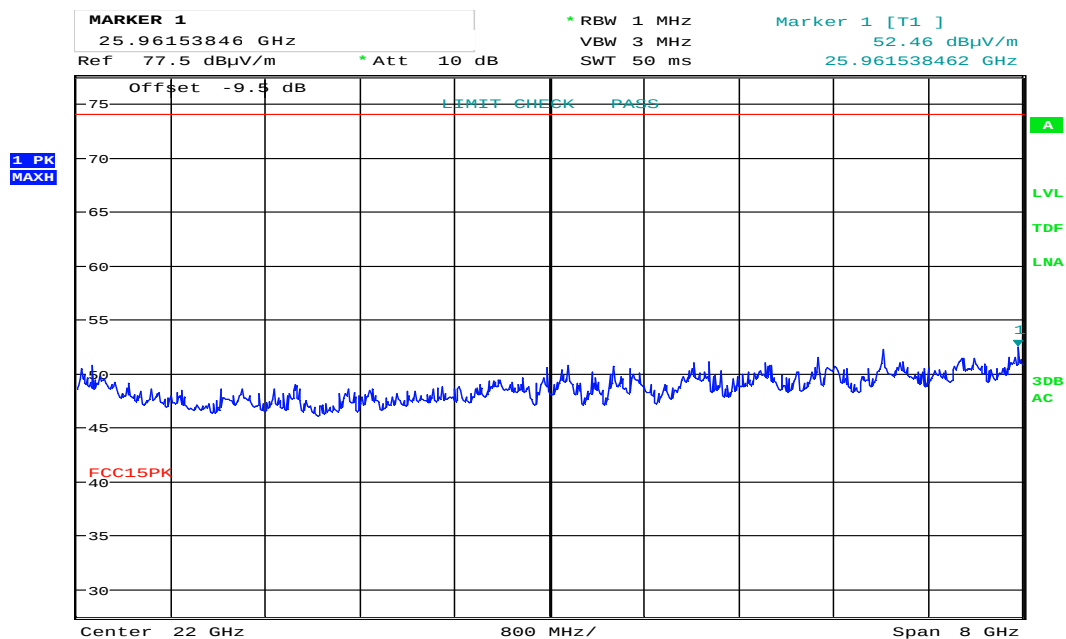
Date: 25.NOV.2019 16:08:20

Radiated Emissions, 3 – 18 GHz, 2475MHz, HP



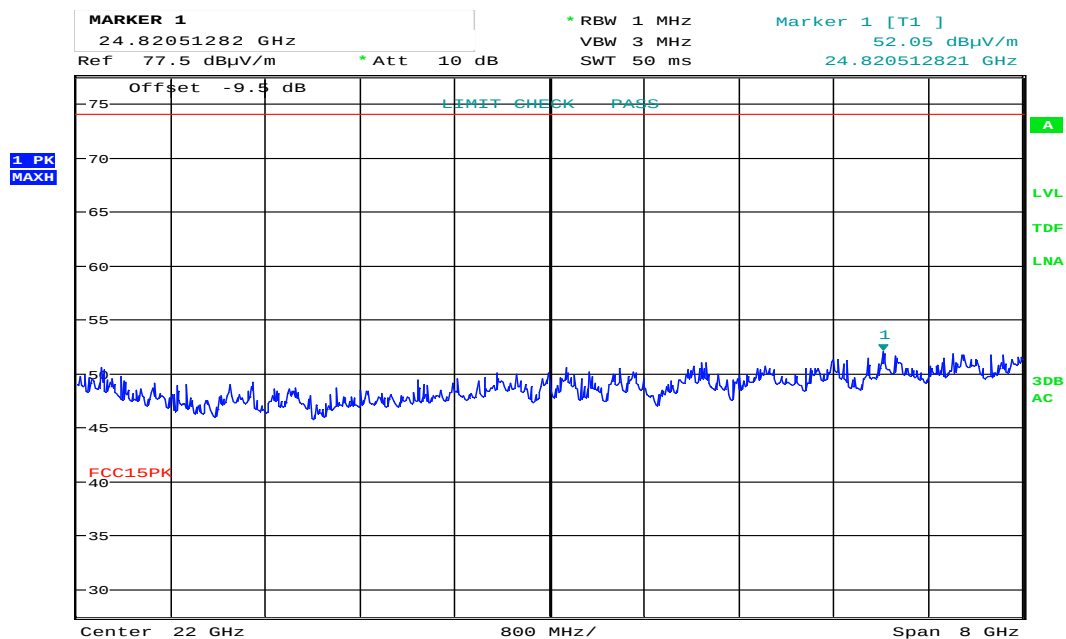
Date: 25.NOV.2019 16:06:24

Radiated Emissions, 3 – 18 GHz, 2475MHz, VP



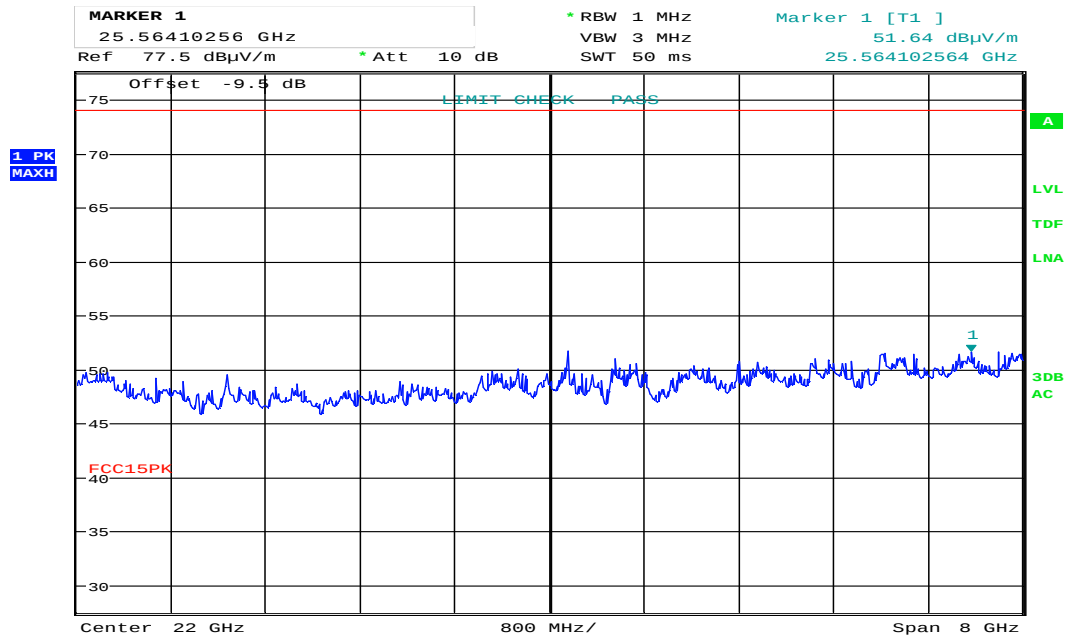
Date: 25.NOV.2019 13:04:52

Radiated Emissions, 18 – 26 GHz, 2405MHz, HP



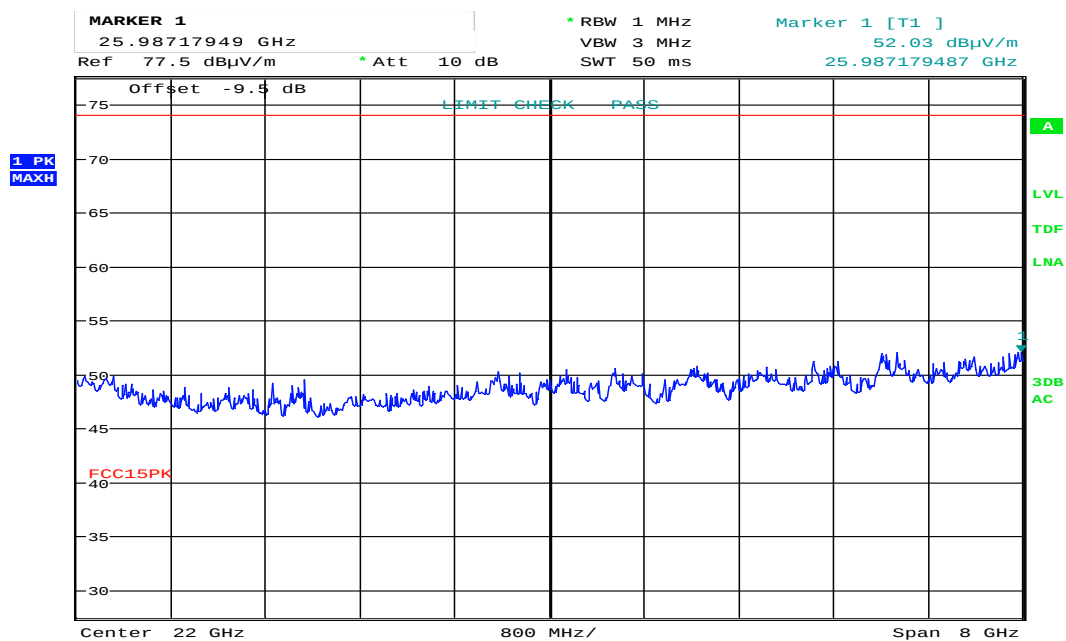
Date: 25.NOV.2019 13:04:11

Radiated Emissions, 18 – 26 GHz, 2405MHz, VP



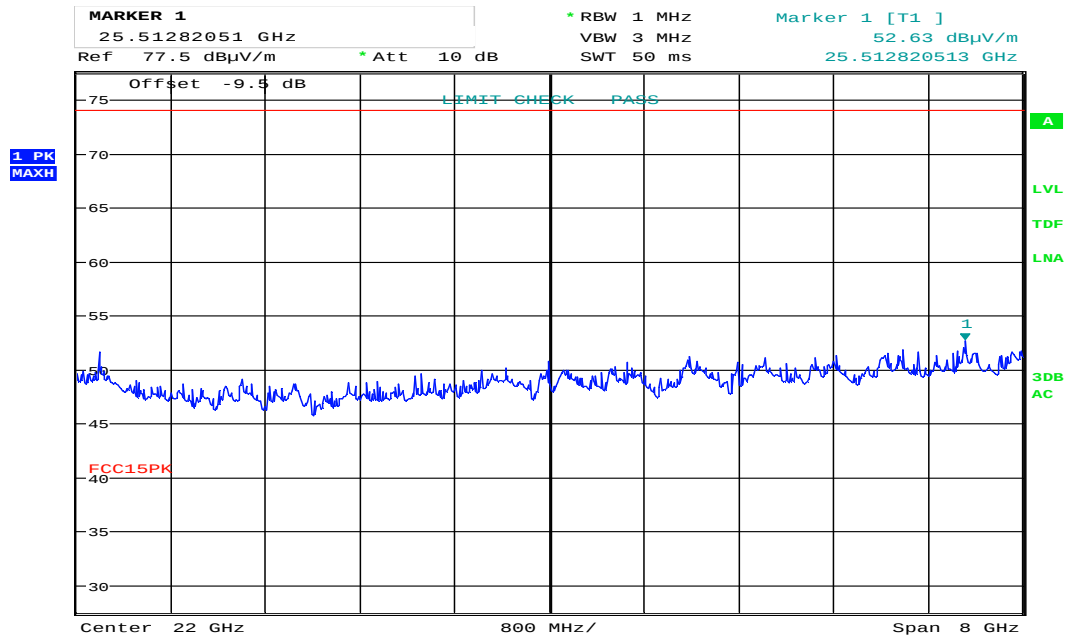
Date: 25.NOV.2019 13:11:41

Radiated Emissions, 18 – 26 GHz, 2440MHz, HP



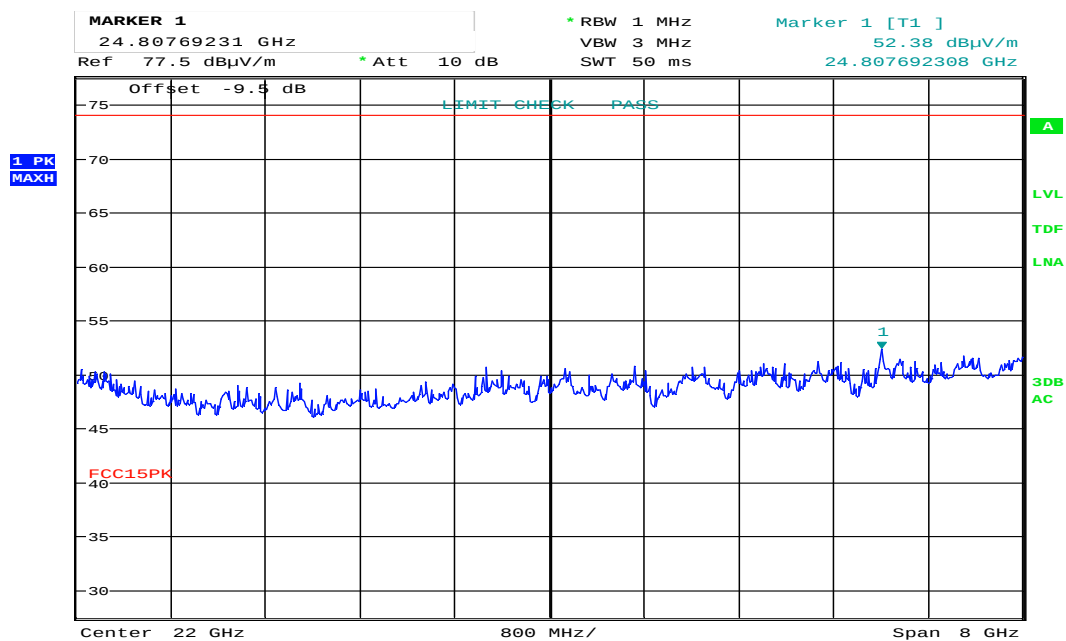
Date: 25.NOV.2019 13:12:31

Radiated Emissions, 18 – 26 GHz, 2440MHz, VP



Date: 25.NOV.2019 13:20:16

Radiated Emissions, 18 – 26 GHz, 2475MHz, HP



Date: 25.NOV.2019 13:21:19

Radiated Emissions, 18 – 26 GHz, 2475MHz, VP

3.9 Power Spectral Density (PSD)

FCC part 15.247(d)

ISED Canada RSS-247 Issue 2, Clause 5.2 (2)

Measurement procedure: ANSI C63.10-2013 Clause 11.10

Test Results: Complies

Measurement Data:

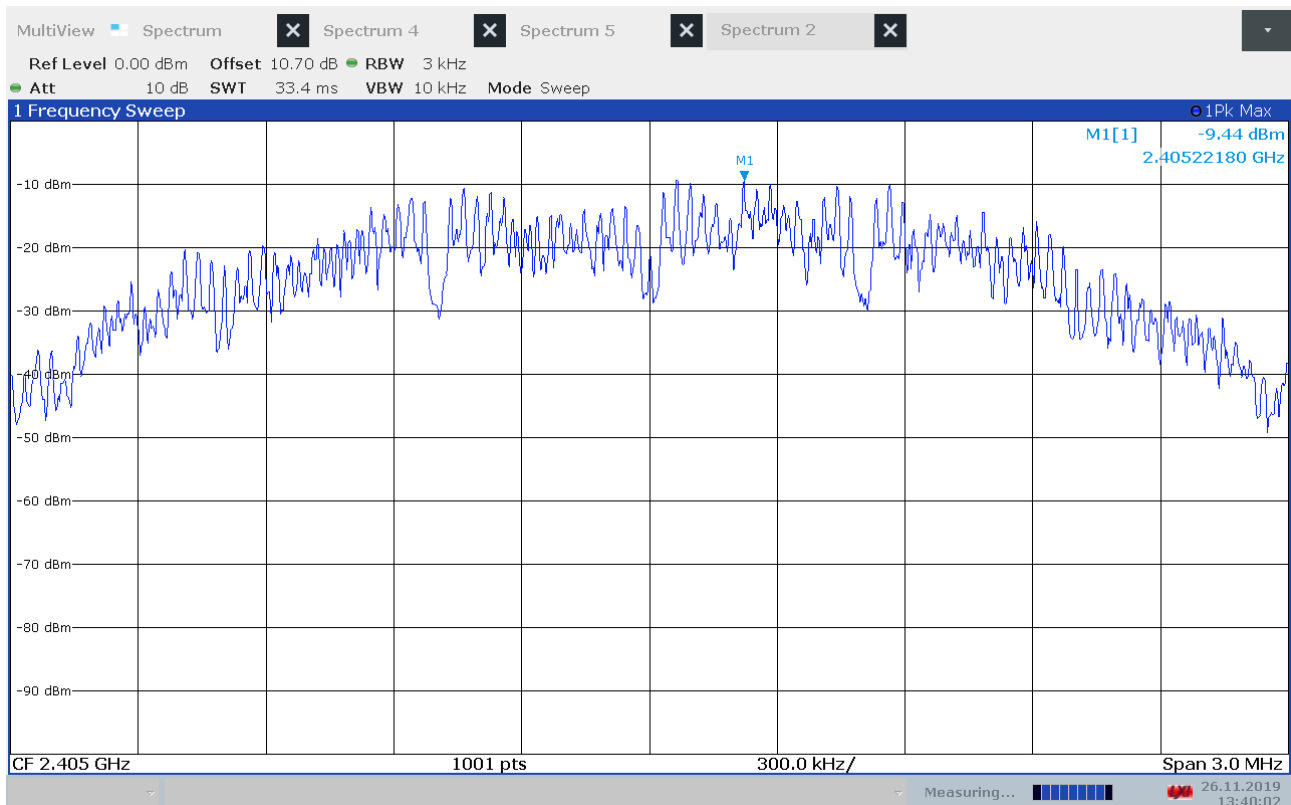
The measurement procedure PKPSD described in ANSI C63.10-2013 was used.

Carrier Frequency	Measured Power Spectral Density (dBm/3kHz)
2405 MHz	-9.4
2440 MHz	-9.3
2475 MHz	-8.6

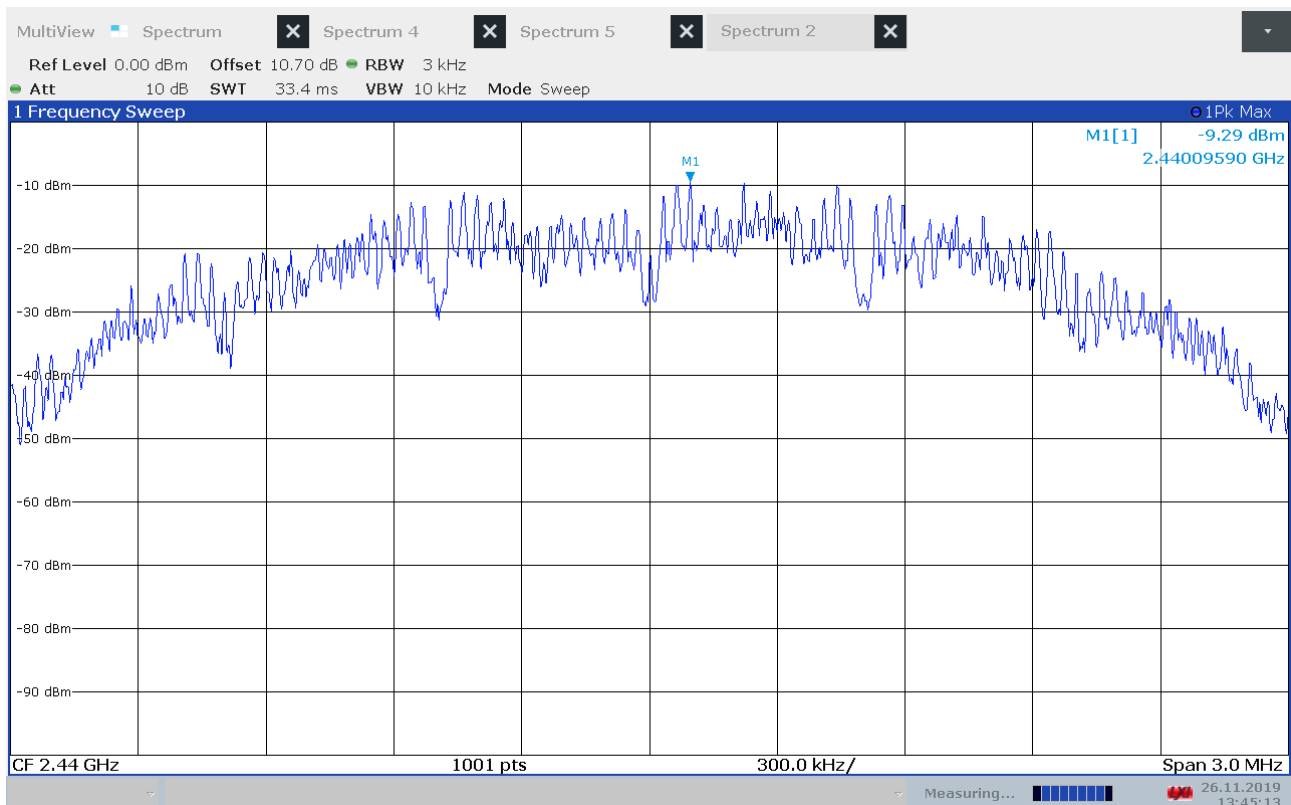
Requirements:

The Power Spectral Density of a Digital Transmission System shall be no greater than +8 dBm in any 3 kHz band

No requirements for Frequency Hopping Systems.



Power Spectral Density, 2405 MHz



Power Spectral Density, 2440 MHz



4 Measurement Uncertainty

Measurement Uncertainty Values		
Test Item		Uncertainty
Output Power		±0.5 dB
Power Spectral Density		±0.5 dB
Out of Band Emissions, Conducted	< 3.6 GHz	±0.6 dB
	> 3.6 GHz	±0.9 dB
Spurious Emissions, Radiated	< 1 GHz	±2.5 dB
	> 1 GHz	±2.2 dB
Emission Bandwidth		±4 %
Power Line Conducted Emissions		+2.9 / -4.1 dB
Spectrum Mask Measurements	Frequency	±5 %
	Amplitude	±1.0 dB
Frequency Error		±0.6 ppm
Temperature Uncertainty		±1 °C

All uncertainty values are expanded standard uncertainty to give a confidence level of 95%, based on coverage factor k=2

5 LIST OF TEST EQUIPMENT

To facilitate inclusion on each page of the test equipment used for related tests, each item of test equipment and ancillaries are identified (numbered) by the Test Laboratory.

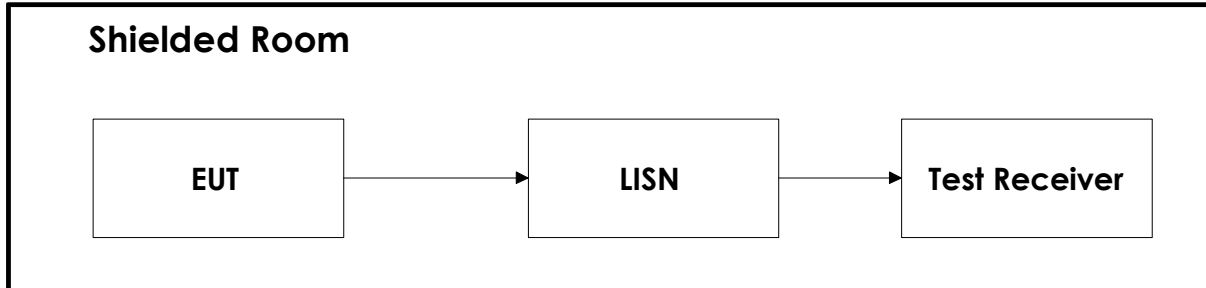
No.	Model number	Description	Manufacturer	Ref. no.	Cal. date	Cal. Due
1	FSW43	Spectrum Analyzer	Rohde & Schwarz	LR 1690	2019.01	2020.01
2	ESU40	Measuring Receiver	Rohde & Schwarz	LR 1639	2019.01	2020.01
3	6810.17B	Attenuator	Suhner	LR 1669	2019.07	2020.07
4	6HC3000/18000	Highpass Filter	Trilithic	LR 1614	2019.07	2020.07
5	JB3	BiLog Antenna	Sunol Sciences	N-4525	2017.11	2020.11
6	Model 317	Preamplifier	Sonoma Inst.	LR 1687	2019.07	2020.07
7	3115	Horn Antenna	EMCO	LR 1330	2016.10	2021.10
8	8449A	Pre-amplifier	Hewlett Packard	LR 1322	2019.07	2020.07
9	3117-PA	Horn Antenna with PreAmp	EMCO	LR 1717	2017.12	2019.12
10	638	Antenna Horn	Narda	LR 1480	2010.06	2020.06

The software listed below has been used for one or more tests.

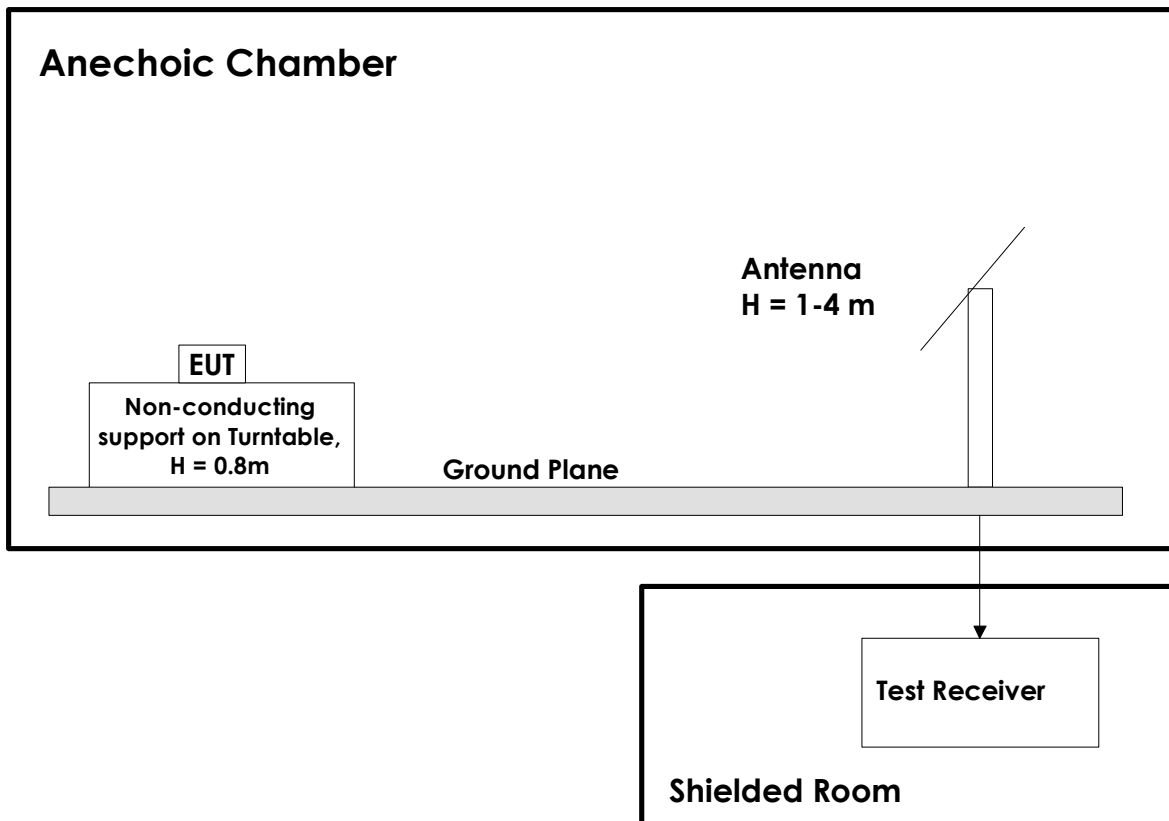
No.	Manufacturer	Name	Version	Comment
1	Rohde & Schwarz	EMC32	10.50.10	Power Line Conducted test software
2	Rohde & Schwarz	EMC32	10.50.10	Radiated Emission test software
3	Rohde & Schwarz	GPIBSHOT	2.7	Screenshots from R&S Spectrum Analyzers

6 BLOCK DIAGRAM

6.1 Power Line Conducted Emission



6.2 Test Site Radiated Emission



This test setup is used for all radiated emissions tests. For frequencies below 30 MHz the measuring distance is 10m, for all other frequencies it is 3m or 1m. Emissions above 1 GHz are measured with a Spectrum Analyzer and Horn Antenna. For measurements above 18 GHz the test receiver is moved inside the anechoic chamber and located next to the antenna to minimize the cable loss. All measurements at 1GHz and above were performed with turntable height 1.5m and with the ground plane covered by absorbers. A pre-amplifier is used for all measurements above 30 MHz, and High-Pass or Band-Pass filter is used for all harmonics.